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COLLOIDS AND CRYSTALS, THE TWO WORLDS OF MATTER.

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1.

When a solid is brought into contact with a liquid the result depends upon the nature of both. There may be apparently an entire absence of interaction, as when rosin is shaken up with water or chalk with alcohol; or, as when sugar is agitated with water the solid may disappear entering into solution in the liquid. The study of sugar solution shows quite clearly that the connection of the sugar molecules with each other has been completely destroyed. They are dispersed through the water very much as the molecules of a gas distribute themselves uniformly in a vacant space, and in both cases the permanence of the uniform dispersion is due to the incessant motion of the molecules. Were the molecules at rest, both the sugar and the gas would settle and form a layer on the bottom of the containing vessel. However, the molecules of sugar retain their structure intact, the action being limited to their dispersion. When salt, on the other hand, is dissolved in water a further breakdown occurs, the molecule is separated and ions of sodium and of chlorine move about the liquid. Both solutions freeze below 0° C. and boil above 100° C. The most important differences between them is that the salt solution conducts the electric current, while the sugar solution is as bad a conductor as water itself.

A fourth possibility presents itself when glue or gelatine is heated with water. The gelatine absorbs water, swells up and under the influence of heat, dissolves, but the liquid freezes and boils at practically the same temperatures as pure water. The study of the solution shows that the dispersion is not molecular.

The particles of gelatine in it are composed of variable and rather large numbers of molecules. A system like this gelatine solution which presents a case of very fine but not molecular subdivision is called a *colloidal solution*. There are certain solids such as gelatine and dextrin (with water), rubber (with benzene and carbon disulphide) which, when they dissolve in liquids, are invariably dispersed in this way. Such solids may properly be referred to as *colloids*: They are all amorphous. Crystallized substances never yield colloidal solutions by mere spontaneous solution in a liquid. They always produce molecular or ionic dispersions. However the phenomenon of colloidal solution is perfectly general and crystallized substances can also be obtained in colloidal solution.

It is an interesting fact that a substance which yields a colloidal solution with one solvent may form an ordinary molecular solution with another. Soap is an example. Its concentrated solution in water boils at about 100 degrees, freezes at about 0 degrees and exhibits the behavior of a colloidal solution in general. On the contrary a soap solution in alcohol shows the normal change in freezing and boiling points corresponding to the molecular weight and conducts itself in all respects like an ordinary molecular dispersion.

2.

Everyone is familiar with the distinction between solutions and suspensions. Suspensions are turbid in aspect and the solid can be removed by letting it settle or by filtration. Solutions contain clear dissolved matter which does not subside, and is unaffected by filtering. Colloidal solutions occupy an intermediate position.

Consider for a moment the effect of increasing subdivision on a suspension of finely divided gold in water. So long as the diameter of the particles is much greater than a thousandth of a millimeter[1] the system will be turbid and the gold will settle rapidly. But the wave-length of visible light ranges between 0.4μ and 0.7μ and when the particles become smaller than this they can no longer reflect light and the liquid will appear clear. At the same time there will be a rapid falling off in the speed of settling. Stokes has derived a formula for the velocity of

[1]It is usual to employ the symbol μ (the Greek letter mu) for the thousandth of a millimeter. In the same way $\mu\mu$ indicates the millionth of a millimeter.

subsidence of small spheres of radius R and density S falling in a liquid of density S′ and internal friction f under the force of gravity g:

$$V = \frac{2}{9} \cdot g\,(S - S')\,\frac{R^2}{f}$$

Substituting the proper values for gold and water and assuming a radius of μ for the particles the value for V is about 14 centimeters per hour. This means, of course, that the system would be a coarse suspension and would clear up at once. But when $R = 10\,\mu\mu$, V is only about a centimeter a month. This begins already to be fairly permanent. It must be remembered that the high density of gold (19.5) increases the rapidity of subsidence. If we make the calculation for $S = 3$, which is about the density of arsenious sulphide, V comes out only about a millimeter a month.

So much for calculation. Now what are the facts? As a matter of fact the dispersed substance in a colloidal solution does not settle at all, so long as the subdivision is maintained. Colloidal gold solutions have been preserved unchanged for years. I have a solution of arsenious sulphide which has remained apparently unchanged for three years, and whose countless particles can readily be seen, engaged in their incessant Brownian movement, with an ordinary oil immersion lens. Whenever settling does occur, it is preceded by the aggregation of the particles into larger particles, which finally attain a diameter of μ or over and slowly subside.

Here then is an apparent discrepancy between Stokes' law and the facts. The law informs us that the speed of subsidence decreases rapidly with decreasing radius of the particles but it does not lead us to expect the total absence of settling which presents itself when the average radius is $10\,\mu\mu$, or thereabouts.

The explanation, of course, is molecular motion, or in other words, *heat*. The particles are battered on all sides by a hailstorm of molecular impacts. If the particle is large, the blows of the molecules of the solvent in different directions neutralize each other. But when the particle is not so very much larger than the molecules themselves, a molecule striking, say on the left, will give the particle a very perceptible push toward the right "just as a cork follows better than a large ship the motion of the waves of the sea."[2] As the dimensions of the particle

[2] Perrin.

approach the molecular dimensions, it begins to behave like a molecule and is swept along in the endless molecular movement. The cause which prevents the particles in a colloidal solution from settling is in no way different from the cause which prevents the earth's atmosphere from subsiding to a snowy layer a few feet deep on the surface of the planet.

It is worth remembering also that the particles of the dispersed phase ordinarily possess an electric charge which is usually negative. The effect of the repulsion of these similar charges would be to preserve the distribution of the particles throughout the liquid. It is a fact that, when the charges are removed, the system becomes instable and subsidence—preceded by coalescence of the small particles—readily, but not necessarily, occurs.

3.

On the subject of the classification of colloid systems we must be very brief. One proposal subdivides them into *suspensoids,* such as the sols[3] of gold and arsenious sulphide, in which the dispersed phase is solid, and *emulsoids,* in which the dispersed phase is liquid. This classification would appear to be an attempt to extend the familiar distinction between liquid and solid to a domain in which that distinction has little if any meaning. To assert that a thing is solid is to say that it has a definite shape which it retains with some persistence. There is not the slightest reason to think that the particles in a gold sol are solid. It is usual to assume that they are spherical, but this is done merely because it is the simplest assumption to make. There are faint indications that they really have the form of leaflets or of little rods, but they appear in the ultra-microscope simply as brilliant dancing points and in reality we know nothing whatever about their shape. In connection with this it is interesting to recall the fact that the formation of a crystal begins with the appearance of minute liquid spheres (globulites),[4] which pass through several stages (margarites, longulites, etc.) before the crystal is formed. It seems possible that under such enormous subdivision, cohesion retires into the background and surface tension assumes the chief rôle so that the gold particles are rather to be compared to minute drops than to little crystals.

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[3]Thomas Graham introduced the term sol as an abbreviation for colloidal solution.

[4]Link Poggendorff's Annalen, Vol. 46, p. 258 (1839); Schmidt, Liebig's Annalen der Chemie, Vol. 53, p. 171 (1845); Frankenheim Poggendorff's Annalen, Vol. 3, p. 1 (1860).

Enough has been said to make clear the uncertainty which attaches to the attempt to classify colloid solutions according to the state of aggregation of the particles. A better classification is into *reversible* and *irreversible* colloids according to the way in which the dissolved substance behaves when separated from the solution. Thus when a gelatine solution is evaporated until it "sets" it is only necessary to warm the jelly with water to obtain it again in colloid solution. Gelatine is a typical reversible colloid. But when the gold is caused to separate from a gold sol—which can easily be brought about by adding any electrolyte to the sol—the gold will not again enter into colloidal solution. Shaking or warming with water gives a mere suspension, which settles at once. Gold is an *irreversible* colloid. The distinction is fundamental. Many organic colloids are reversible, while it is rather the habit of the inorganic colloids to behave in the irreversible way.

4.

In order to prepare a sol—containing an irreversible colloid—all that is necessary is to reduce the solid to extreme subdivision in a liquid in which it is insoluble. The electric arc furnishes a rapid and simple method.[5] Two gold wires about 2 inches in thickness are connected with a 220 volt circuit and brought together under distilled water. A 110 volt circuit can be used but more patience is required. Sols of platinum, silver, copper and other metals can be made in the same way. By related electrical methods using such liquids as pentane and anhydrous ether, Svedberg[6] obtained sols of all five of the alkali metals. The colors of the sols agreed with those of the vapors of the corresponding metal.

Chemical reduction of a salt of a metal furnishes another method which has been largely employed by Zsigmondy[7] and other investigators. For instance, a very dilute solution of auric chloride is mixed with such reducing agents as formaldehyde, hydroxylamine or an ethereal solution of phosphorus. The gold sols obtained in this way are usually red, the particles being bright green and very much smaller than in the sols obtained by the electrical method.

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[5]Bredig Zeitshrift für angewandte Chemie, 1898, P. 951. For a full account of Bredig's work with the platinum sol see Zeitschrift for physikalische Chemie, Vol. 31, pages 25 to 353 (1899).

[6]Berichte der Deutchen Chemischen Gesellschaft ore 38 p. 3616 (1905).

[7]See his minograph Zur Erkentniss der Kolloide (Jena 1905) which has been translated by Jerome Alexander.

By various chemical methods which lack of space forbids us to discuss, sols of sulphides (C S, As_2S_3, Sb_2S_3, etc.) and oxides (Fe_2O_3, Al_2O_3) can be obtained. The sol of aluminium oxide is important on account of its connection with dyeing and mordanting. The formation of the blood-red sol of ferric oxide by adding a concentrated solution of ferric chloride to about 50 volumes of boiling distilled water is a simple and beautiful lecture experiment.

In making colloidal solutions of salts, the essential thing is to mix dilute solutions of the precipitants using a liquid in which the insolubility of the product is as complete as possible. Thus in mixing very dilute solutions of sodium sulphate and barium chloride, a crystalline precipitate is usually obtained. The reason is that barium sulphate possesses a very slight but real solubility in water. Hence the liquid in contact with the particles first formed contains enough barium sulphate to nourish their growth and allow them to develop into crystals. If alcohol is added to the sulphate, before the barium chloride is introduced, the solubility of the barium sulphate is greatly reduced and it is obtained in colloidal solution without difficulty. In the same way, if we mix water solutions of sodium hydroxide and of hydrochloric acid we obtain merely an ordinary solution of common salt. But if salt is produced by a reaction between organic compounds in a liquid in which sodium chloride is insoluble then a colloidal solution is obtained. For instance, when chlor-acetic ester interacts with sodio-malonic ester, a grayish opalescent sol of sodium chloride results. At low temperature, in such liquids as toluene and chloroform, even *ice* has been obtained in colloidal solution.

5.

The most striking property of the reversible colloids is that they are able to communicate their reversibility to the irreversible ones. Thus, if a trace of gelatine is added to a gold solution, the gold becomes much more difficult to coagulate by electrolytes and when coagulated, it can be dispersed again by merely warming with water. This curious protective action is exerted in greatly varying degree by most reversible colloids. Direct study of the phenomenon with the ultra-microscope shows that the view frequently expressed that the gelatine envelope forms a film around the gold particles is incorrect. What actually happens seems to be a direct combination between gelatine particles and gold particles, which then pass through the reversible changes together.

Protective colloids enjoy a wide practical application. In the manufacture of photographic films the gelatine retards the crystallization of the silver bromide. Ink often contains a colloid which prevents the pigment from settling. The lubricant "aquada" put in the market by the Acheson Co., consists of finely divided artificial graphite, held up by a protective colloid. Clay is made plastic for the potter by an empirical process which involves the action of the protective colloid derived from decaying vegetable matter. The addition of gelatine in making ice cream depends upon its protective action in preventing the growth of ice crystals which would make the product "gritty." Without doubt protective action plays an important rôle in the cleansing action of soap. This has been made clear by some recent experiments of Spring.[8] Lampblack freed from oil by long washing with alcohol, ether, and benzene, forms a rather stable suspension in water, but the lampblack is detained by a paper filter. If the filter is now reversed so that the blackened surface is outward and water poured through it the lampblack is not removed. But a dilute soap solution removes the coating and cleanses the filter at once. Finally lampblack suspended—or colloidally dissolved—in soap solution passes through a filter unchanged. It is of much practical interest that there is a well-marked optimum in the concentration of the soap required to protect the lampblack. A one per cent soap solution is the most efficient. In two per cent soap solution lampblack sinks about as rapidly as in pure water.

6.

We have already considered the probable actual condition of the particles in a colloidal solution and have concluded that for the present no very definite information is obtainable about the matter. We must now return, for a moment, to the subject in order to allude to the thesis so brilliantly advocated by von Weimarn, the Russian investigator who holds that the particles are of necessity minute crystals and that there is in fact, no such thing as amorphous matter. He even goes so far as to state that substances like air and water are in a "dynamic cryptocrystalline condition," though I have been unable to understand what he means by this statement.

Briefly, the evidence that von Weimarn adduces to the support of his hypothesis is:

[8]Kolloid Zeitschrift, Vol. 4, p. 161 (1909); Vol. 6, p. 11, p. 109, p. 164 (1910).

1.—Most colloid particles will grow to crystals if provided with the proper nourishment, namely a diluted solution of the same substance.

2.—Most colloid particles are capable, when introduced into a supersaturated solution of the same supersaturations and inducing the formation of crystals.

Those who desire to follow this matter further should read von Weimarn's little book, "Grundzüge der Dispersoidcheme," after which they will find themselves very much interested but somewhat inconvinced. Let me hasten to add that I have not the least desire to undervalue the brilliant experimental work of the Russian chemist. It is in fact precisely by the conception of more or less daring hypotheses and then working out their consequences that our science achieves its endless victory over the nescience about us.

7.

We have seen that the wave lengths of the visible radiations are comprised between 0.4 μ and 0.7 μ. With objects much smaller, the ordinary microscopic method ceases to be applicable. Using ultra-violet radiation for illumination, quartz lenses in the microscope, and receiving the image with the photographic plate instead of the eye it is possible to advance a step farther in the domain of the infinitesimal, but only a step and there are obvious objections to the proceeding.

Since some of the particles in colloidal solutions are only 0.006 μ in diameter we can never hope to see them as little bodies subtending a visual angle. The *ultra-microscope*—the powerful instrument of investigation to which most of our knowledge of colloid systems is due—announces this idea and makes the particles visible merely as glittering points on a black background. The sol is placed in a small rectangular glass trough and a horizontal beam of arc light or sunlight focused in it. The microscope is placed vertically above the trough. It will at once be seen that there are two fundamental things about the instrument: To provide intense illumination and to make sure that no light enters the microscope except the rays which emanate from the particles. The principle is simple but the system of diaphragms and lenses needed to secure the second object makes it an elaborate and expensive instrument in practice.

Cotton and Mouton[9] achieve the same end in a different way.

[9]Compt. Rendus, Vol. 136, p. 1657 (1903).

The illumination (arc or sunlight) is thrown up from below by a paraboloid reflector so ground that all rays *except those diffracted by the particles* are totally reflected from the cover glass over the sol. This instrument is simple, easily adjusted and cheap. It is made commercially by the firm of Zeiss. It would seem to be admirably adapted to school purposes. In fact, after a look into the ultramicroscope, the study of the molecular topics ceases to be drudgery and becomes a positive intellectual need.

8.

Even a brief glance at the subject of colloid systems must at least mention the classic work of Perrin[10] on the distribution of the particles in suspensions of gamboge and mastic. He succeeded by an ingenious and simple method in preparing emulsions of gamboge in water in which the spherical yellow granules were all of the same diameter. If we consider a mass of such a liquid in a tube it is clear that the granules, if at rest, would, since they are denser than water, all fall to the bottom. The fact that they remain suspended is due to their movement. In other words, the state of things is the same as in the earth's atmosphere and just as the molecules are more crowded near the earth's surface so the granules of gamboge must be more numerous near the bottom of the liquid than in the upper layers. Perrin verified this prediction by direct counting of the granules under the microscope. The barometric formula which describes the progressive rarefaction of air with increasing height also describes the distribution of the granules in Perrin's uniform emulsions. The only difference is that while the aviator must ascend six kilometers in order to reach air half as dense as at sea level the same effect is produced, in Perrin's emulsion, by an ascent of 0.1 millimeter.

That the mean energy of rotation of a molecule must be equal to its mean energy of translation is one of the chief propositions of the kinetic theory. Perrin has proved this by direct measurement of the rotation of granules under the microscope. For this purpose, large granules (15 μ) of mastic were employed. These are far too heavy to remain suspended in water, so a solution of urea was used. Fortunately the granules contain little inclusions which makes it possible to measure their rotation.

[10]Annales de chimie et de Physique. 3rd series, vol. 18, p. 5 (1909). There is a German translation by Donan in Kolloide chemische Beihefte, vol. 1, p. 1 (1909). An English translation by Soddy. His appeared in book form under the title "The Brownian Movement And Molecilar Reality."

These are only two of many fundamental results contained in this wonderful memoir. Van t. Hoff extended the gas laws to solutions. Perrin has now proved them to be valid for systems in which the moving particles are visible realities. Let us end by quoting one of the sentences of his conclusion: "La découverte de telles relations marque le point où s élève dans notre conscience scientifique la réalité moléculáire sousjacente."

FOR NINE MONTHS OF SCHOOLING IN THE COUNTRY.

"We ought to have nine months of free schooling for every child in the rural districts," says Dr. P. P. Claxton, United States Commissioner of Education. In a letter to the superintendents of public instruction in the various states Dr. Claxton calls attention to the present short rural term and makes an earnest plea for a campaign by the state officers to bring the school term for country schools up to that for city schools. Many of the state superintendents have already pledged their assistance in a nation-wide movement to bring this about.

Dr. Claxton points out how far we are in this country from approximating at present even the lowest minimum he names—a school term of 160 days. The average length of the rural-school term is only 138 days, or a little less than seven months, while for the cities it is 184 days, or more than nine months. Only two states, Connecticut and Rhode Island, have school terms exceeding nine months in rural districts. Eleven others have country-school terms of between eight and nine months. They are: California, Iowa, Michigan, Maryland, Kansas, Nebraska, New Jersey, New York, South Dakota, Washington and Wisconsin.

Many states are considerably below the seven months' average. In a number of them the country schools keep open for only six months; Florida and Arkansas keep their schools in rural districts open for five months; while North Carolina, South Carolina, and New Mexico have apparently been providing their country children with barely four months and a half of schooling every year.

Nearly all the city schools, the Commissioner shows, already have nine-months' terms, 180 days or more, with well-trained teachers, and there is no reason, he declares, why the country children should not have as many days of schooling and as good teachers as boys and girls in the city. Dr. Claxton asks a minimum school term for the rural districts of eight or nine months (eight temporarily); a minimum qualification for rural teachers of four years of high school and not less than two years of college or normal education, and good libraries for all rural schools. "With these," he says, "should go an effort to adjust the work of the rural schools more closely to the needs of country life."

A number of the states with short rural terms are making splendid efforts to bring the country schools up to the standard of their city schools, in length of term and other essentials. Dr. Claxton believes that all the states will be aided by a concerted movement for better rural schools throughout the nation.

THE ROCK FROM SOLOMON'S QUARRIES.

BY NICHOLAS KNIGHT,
Cornell College.

A specimen of the rock from Solomon's quarries was lately received by us for analysis. It is the material that entered into the construction of Solomon's Temple, characterized by Dr. Lyman Abbott as an "architectural splendor." It is of snowy whiteness, soft when first removed from the quarry, but soon hardens on exposure to the air. The natives call this rock the "Royal." It is rather soft and porous, and extends underneath the city. There is another variety on a higher level above the soft strata of the "Royal," a hard limestone, which is locally called the "Hard Jewish." The analysis was made in the Cornell laboratory by G. H. Wiesner, as follows:

$Ca\ Co_3$	99.32 per cent
$Mg\ Co_3$	0.67 per cent
	99.99 per cent

There is not a trace of silica, iron or alumina, but it is almost a perfect specimen of calcium carbonate with a small quantity of magnesium carbonate. It is a purer limestone than[1] Carrara marble.

Tyndall said the water of Lake Geneva, Switzerland, is the purest natural water ever analyzed, and it has occurred to us whether there is another limestone as pure as this for so extensive a formation anywhere on this earth. We would be pleased to hear from readers of this journal on the subject. It would be an ideal rock for Portland cement and for calcium carbide, on account of its low magnesia contents.

The specimen was sent us by Herbert E. Clark, Jaffa Gate, Jerusalem, to whom we wish to record our thanks. Mr. Clark suggested that as the rock comes from under the city, and being porous, that it may have been affected by drainage. But the analysis does not seem to indicate any disturbing influence.

On account of the porosity of the rock we did not get a satisfactory result in determining the specific gravity. By one method we obtained 2.25 and by another process 2.48. The latter would seem to be more nearly the correct value.

[1]This Journal, February, 1911, p. 175.

IMAGE POSITIONS FROM LENSES.

By J. S. Stevens,
University of Maine, Orono.

One of the most difficult problems we meet in teaching optics is the interpretation of the formula

$$\frac{1}{S_1} - \frac{1}{S} = (u-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right).$$

Various text-books give directions for applying the formula which are difficult for the average student to use correctly. I suggest the following rules, which are easy to apply, as meeting all possible conditions:

1. All distances to the right of the lens are positive, and to the left negative.

2. The surface which the light ray meets first shall be called the surface whose radius is r_1. The other surface has a radius of r_2.

S is the object-distance, S_1 the image-distance, and u the refraction index, say 1. 5.

Let us apply these rules to a symmetrical double convex lens.

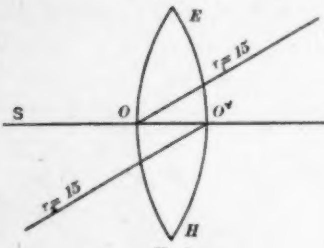

Fig. 1

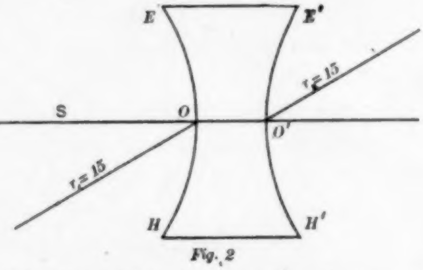

Fig. 2

1. Let S = 20 cm. to the left, E O H is the surface first met and the radius is + 15; E O′ H is the second surface and the radius is — 15. S = — 20. Then

$$\frac{1}{S_1} + \frac{1}{20} = \frac{1}{2}\left(\frac{1}{15} + \frac{1}{15}\right). \qquad S_1 = 60.$$

2. Let S = 12 cm. to the left.

$$\frac{1}{S_1} + \frac{1}{12} = \frac{1}{15}. \qquad S_1 = -60.$$

2. Let S = 15 cm. to the left.

$$\frac{1}{S_1} + \frac{1}{15} = \frac{1}{15}. \qquad S_1 = \infty$$

4. If S = 20 cm. to the right the formula becomes

$$\frac{1}{S_1} - \frac{1}{20} = \frac{1}{2}\left(-\frac{1}{15} - \frac{1}{15}\right) \cdot \qquad S_1 = -60.$$

since r_1 and r_2 have interchanged.

If we take a symmetrical double concave lens we may apply the rules equally well.

1. S = 20 cm. to the left, E O H is the surface first met, and the radius is -15; E′ O′ H′ is the second surface, and the radius is $+15$. S = -20. Then

$$\frac{1}{S_1} + \frac{1}{20} = \frac{1}{2}\left(-\frac{1}{15} - \frac{1}{15}\right) \cdot \qquad S_1 = -8\tfrac{4}{7}.$$

2. S = 12 cm. to the left.

$$\frac{1}{S_1} + \frac{1}{12} = -\frac{1}{15} \text{ (as above)} \cdot \qquad S_1 = -6\tfrac{2}{3}.$$

3. S = 1 cm. to the left.

$$\frac{1}{S_1} + \frac{1}{1} = -\frac{1}{15} \cdot \qquad S_1 = -0.9\tfrac{3}{8}.$$

4. If S is 20 cm. to the right, r_1 and r_2 interchange and we have

$$\frac{1}{S_1} - \frac{1}{20} = \frac{1}{2}\left(\frac{1}{15} + \frac{1}{15}\right) \cdot \qquad S_1 = 8\tfrac{4}{7}.$$

Suppose the surfaces do not have the same curvature.

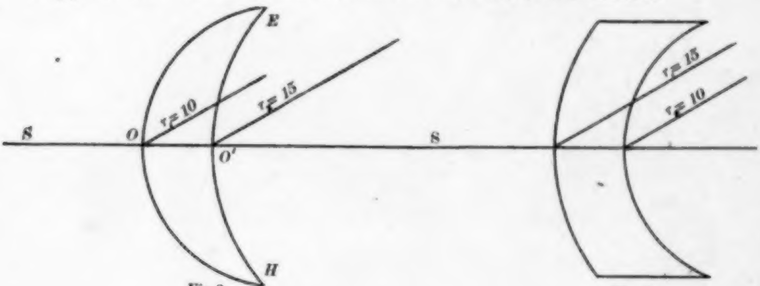

Fig. 3 Fig. 4

1. Let S be 20 cm. to the left.

$$\frac{1}{S_1} + \frac{1}{20} = \frac{1}{2}\left(\frac{1}{10} - \frac{1}{15}\right) \cdot \qquad S = -30.$$

2. Let S be 12 cm. to the left.

$$\frac{1}{S_1} + \frac{1}{12} = \frac{1}{60} \cdot \qquad S_1 = -15.$$

3. If $S = -120$, $S_1 = 120$.

4. If $S = -240$, $S_1 = 80$.

For a diverging meniscus we have the following construction:

1. Let S be 20 cm. to the left.

$$\frac{1}{S_1} + \frac{1}{20} = \frac{1}{2}\left(\frac{1}{15} - \frac{1}{10}\right). \qquad S = -15.$$

2. Let S be 12 cm. to the left.

$$\frac{1}{S_1} + \frac{1}{12} = -\frac{1}{60}. \qquad S_1 = -10.$$

3. If $S = -120$, $S_1 = -40$.

Suppose the two surfaces have equal curvatures with like signs.

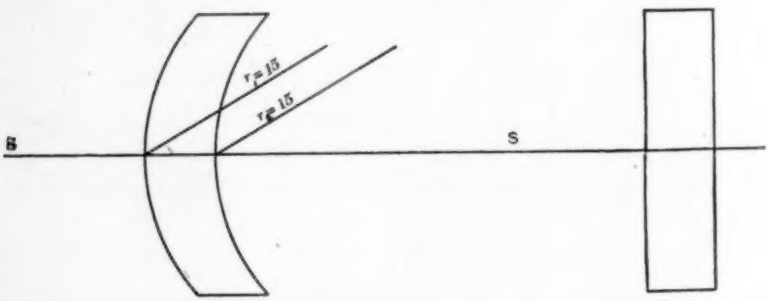

Fig. 5 Fig. 6

1. As before, if $S = -20$ cm. we have

$$\frac{1}{S_1} + \frac{1}{20} = \frac{1}{2}\left(\frac{1}{15} - \frac{1}{15}\right). \qquad S_1 = -20.$$

2. If $r_1 = 16$ and $r_2 = 15$, $S_1 = -19\frac{1}{5}$.

3. If $r_1 = 15$ and $r_2 = 16$, $S_1 = -20\frac{20}{23}$.

The coincidence of object and image may be illustrated by a piece of glass plate.

Since r_1 and $r_2 =$ infinity,

$$\frac{1}{S_1} + \frac{1}{20} = \frac{1}{2}\left(-\frac{1}{\infty} - \frac{1}{\infty}\right). \qquad S_1 = -20.$$

Most of the illustrations used have assumed the object to be at the left; but it is obvious that similar problems could be solved when the object was at the right.

GAS AND ELECTRIC FURNACES FOR PHYSICS LABORATORY WORK.

By H. C. Beltz,
Pratt Institute, Brooklyn.

Furnaces of small capacity having a range of temperature from 1000 to 4000 degrees Fahrenheit are found to be almost indispensable in physics laboratories where the study of heat is made with any degree of thoroughness. The following furnaces have been made at Pratt Institute at a nominal cost and have proven very satisfactory.

The materials necessary for the construction of the gas furnace shown in figures 1 and 2 are galvanized sheet iron stove bolts and a fire-clay mixture consisting of one part of fire clay to one part of asbestos fiber by weight (long fiber asbestos must be used). This mixture can be bought of the American Furnace Company, Johns St., New York City, for $0.06 per pound in forty pound packages and has only to be mixed with enough water to make it thoroughly plastic to make it ready for use. The sheet iron and bolts can be obtained from any tinsmith or hardware and with the proper tools can be made up in one hour. All parts must be held together by rivets or bolts.

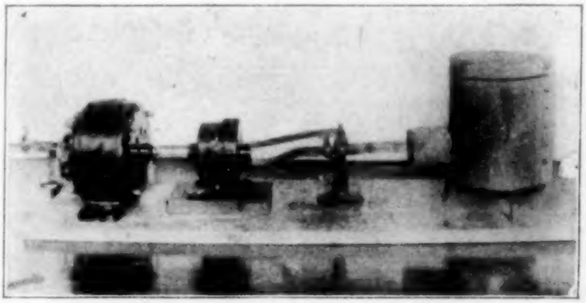

Fig. 1.

In building the walls and bottom of the furnace the outside casing should be let out to its full size and the clay mixture firmly packed on the bottom of the furnace to the depth of one and one-half inches. Then a wooden form, the same shape as the cavity of the furnace, is placed on the bottom already made and the space between the form and the casing is filled with the fire clay mixture and firmly packed in place. In building the

walls of the inlet of the furnace a one inch pipe is very convenient. The pipe is forced in the inlet until it comes in contact with the wooden form and the space between it and the casing is firmly packed with the fire clay mixture. Both the pipe and form are withdrawn as soon as the sides have been made, any unevenness smoothed out and the furnace allowed to dry for several days over a radiator when it will be ready for use. In using the furnace for the first time care must be taken not to heat it up too rapidly.

The cover of the furnace is made of the same material and thickness as the walls, has a one-inch hole left in the center and its edges are protected by a strip of sheet iron one and one-

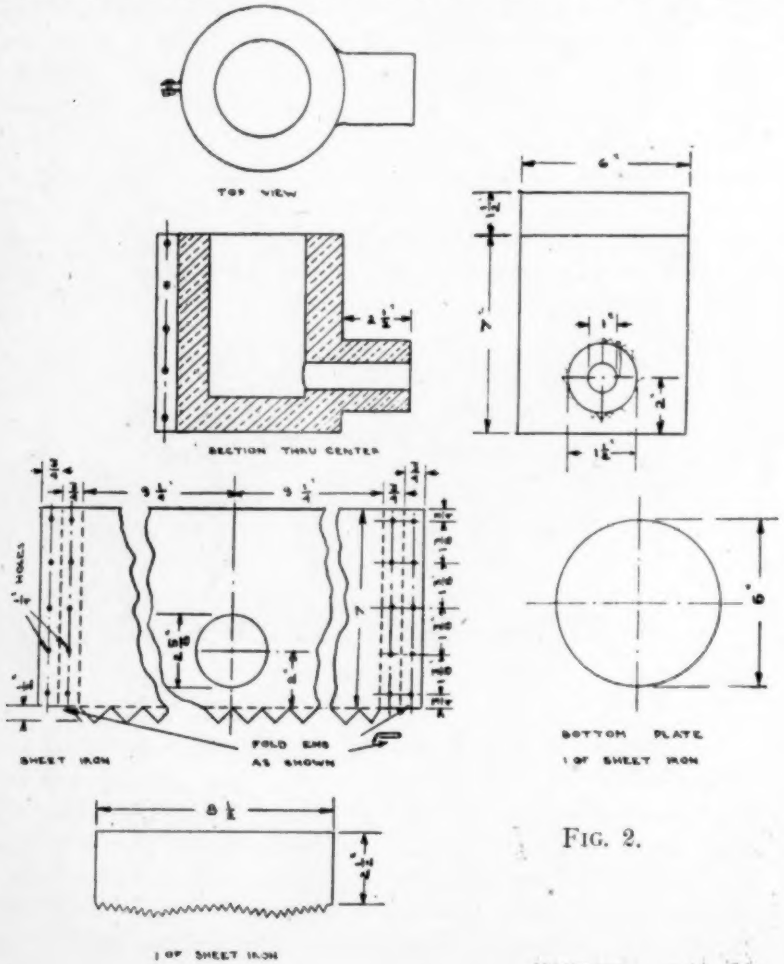

FIG. 2.

half inches wide. The size of the sheet iron casing both for the walls and the cover are adjustable and will fit tightly after shrinkage of the clay has taken place during drying.

The above described furnace will take a crucible of any size up to five by three inches and must be used with a blast lamp. Air for the lamp may be obtained from a pressure tank, a foot bellows or a rotary compressor. At Pratt Institute we use a Bunsen Blast Lamp and a rotary air compressor (manufactured by Lee S. Smith & Sons, Pittsburg, Pa.) operated by a 1/8 H. P. motor. With this equipment the furnace will melt five pounds of lead in four or five minutes and a maximum temperature of 2600 degrees F. can be obtained in ten minutes. A Meker blast will give a temperature of 3000 degrees in the same period. Any temperature up to the maximum can be obtained by regulating the amount of gas and air. This type of furnace has been used for the following experiments at Pratt Institute.

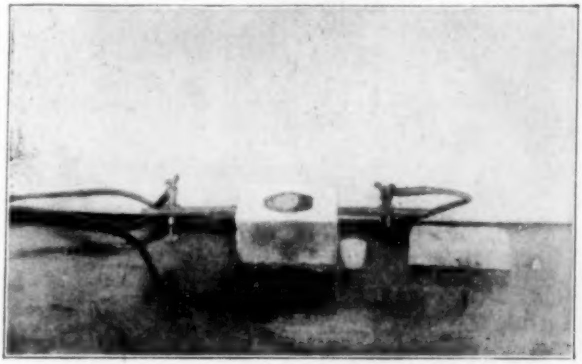

FIG. 3.

1—Cooling curve of a metal.

2—Solidification point of a metal.

3—Calorimeter method of determining the temperature of a furnace.

4—Determination of specific heats of fire clay mixtures, asbestos and metals.

Furnaces of this kind are also useful in chemistry laboratories where a quicker heat and a higher temperature than the ordinary Bunsen burner produces is desired.

The electric furnace shown in figures 3 and 4 can be made in one hour. The materials for its construction consist of fire

clay mixture, electric arc carbons and leads heavy enough to carry fifty amperes. A wooden form of the exact shape of the cavity of the furnace is first made. An ordinary crayon box will serve for the outside mould of the smaller size furnace. The fire-clay mixture is packed in the bottom of the crayon box to the depth of two inches. Then the wooden form is placed in position and the side walls of the furnace are made by packing the fire-clay mixture between the form and the crayon box. In making the ends of the furnace, provision must be made for the carbon electrodes. This can be done by taking two short pieces

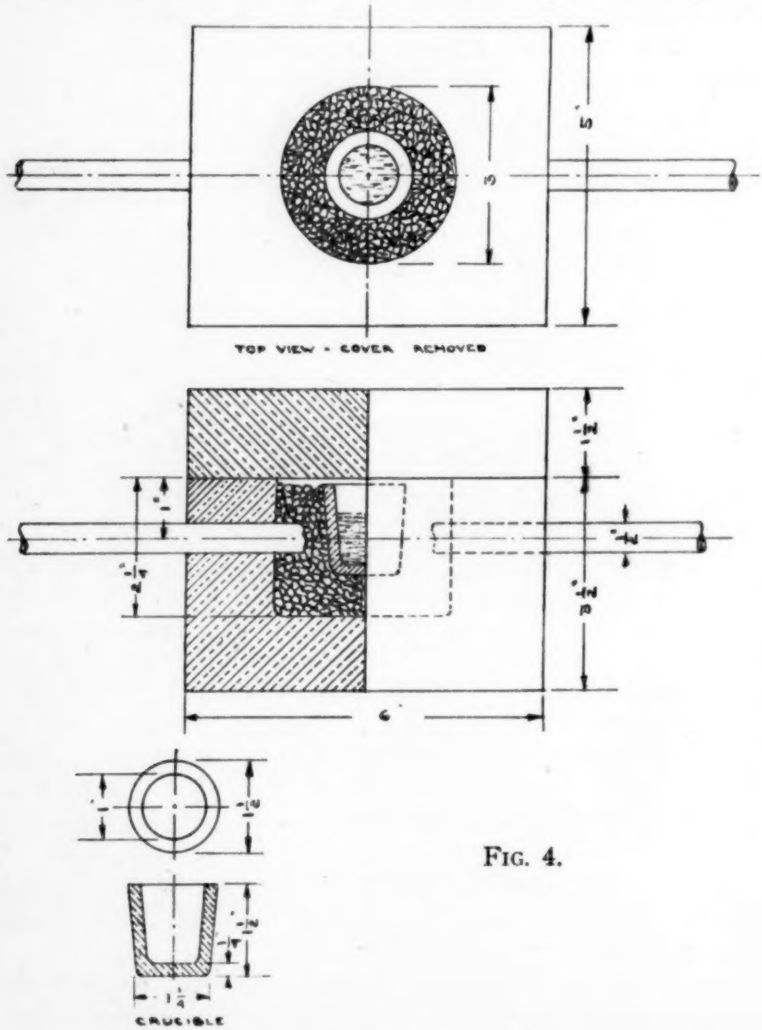

FIG. 4.

of the electric light carbons and embedding them in the end walls as they are built up. Care must be taken to get the short carbons in line so that when they are removed and the long ones put in their place the ends of the long carbons will be opposite each other. The carbons are embedded about one inch down from the top of the furnace walls.

The furnace cover is made of the same material as the furnace walls. It is of the same length and breadth as the furnace and one and one-half inches thick. It can be made most easily by building a retangular form of the required height and filling this with the fire-clay mixture. During the process of drying the clay shrinks and comes out of the form easily. After the clay has partially dried a hole one-fourth of an inch in diameter should be bored in the cover so that it will come directly over the crucible when the furnace is being used.

The crucible used in this furnace gives the best satisfaction and is most durable when made from the fire-clay mixture, and should be of such a size as to allow a space between it and the furnace walls of approximately three-quarters of an inch. In making the crucible a wooden form is used, the clay being moulded evenly on the outside of the form. If the form is dipped in water just before the clay is put on it the clay will come off readily and the shape of the crucible will not be seriously affected. The outside of the crucible can be smoothed by rolling it while on the form against some hard smooth surface. The walls of the crucible should be about three-eighths of an inch thick.

The resistance material for the furnace consists of arc light carbons (the harder the carbons the better) which are broken up in a mortar to the size of cracked corn. After the furnace has dried for several days the carbons are put in position and powdered carbon is placed over the bottom of the furnace cavity to the depth of three-fourths of an inch. The crucible is next placed in position and the space between the crucible and the furnace walls tightly packed with the powdered carbon. The leads may be fastened to the electrodes by means of two ring stand clamps. These clamps need to be modified somewhat by substituting a wing nut for the clamp end. A water rheostat should be placed in series with the furnace to prevent an excessive current.

The above furnace when using from thirty to forty amperes

will melt one hundred and fifty grams of lead in two minutes and boil it in five. A temperature sufficient to melt fire-clay and quartz can be attained in ten minutes. This furnace is extremely easy to operate and is especially adapted for work where the material to be heated is small and where a clean intense source of heat is desired. Below are some of the uses to which this type of furnace has been put at Pratt Institute.

1—Study of cooling curve of a metal.

2—Determination of the solidification point of a metal.

3—Measurement of high temperatures by a pyrometer.

4—Repair work, such as brazing pyrometer tips, fusing of broken quartz casings for pyrometer tips, etc.

The electric drying oven, working drawing for which is shown

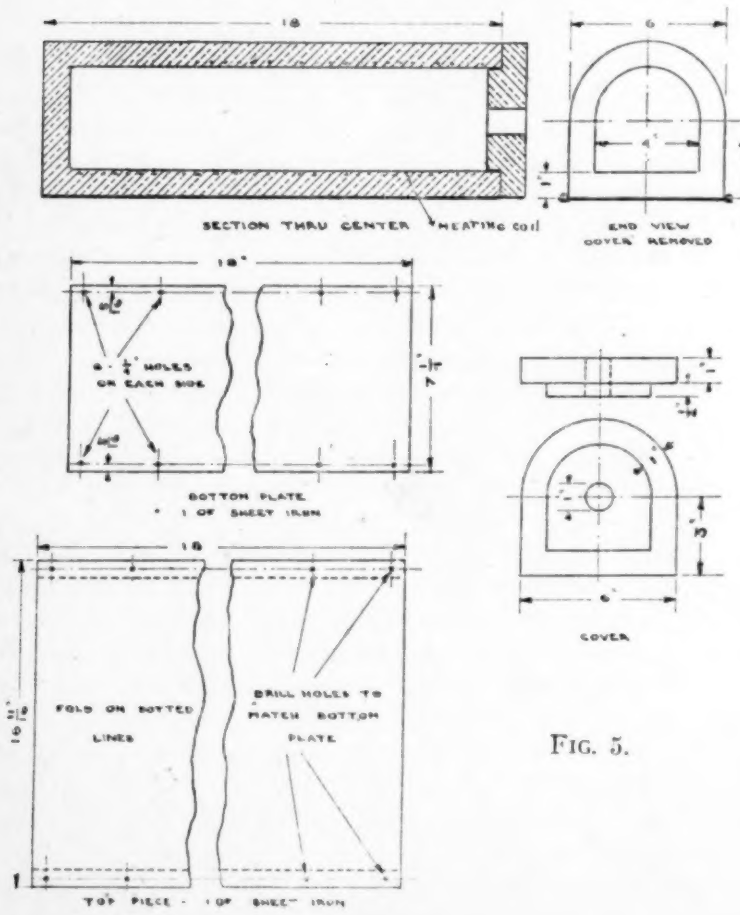

FIG. 5.

in figure No. 5, is made of sheet iron, fire-clay mixture, and any high resistance wire that has a high melting point. Nicrome, Calorite or I. A. I. A. wire gives good results. Such a length and size of wire should be used to give approximately six amperes on a 110 volt circuit. If the higher resistance wire is used it will probably be necessary to have two or more parallel windings in the furnace to get the desired amperage.

In making the furnace a wooden form is used. The form is covered with a fire-clay mixture one-quarter of an inch thick, then the wire is wound on uniformly. The turns in the wire should be about one-half an inch apart, care being taken to keep them separate so there will be no possibility of any of them being short circuited. The wire is now covered with fire clay until the walls are one inch thick. The sheet iron casing need not be fitted until the furnace has thoroughly dried and there is no necessity of covering the ends of the furnace with metal. After the oven has dried slowly for several days it is ready for use. The wooden form can be easily removed after the oven has become hot. The temperature is controlled by placing resistance in the line and very constant temperatures can be maintained up to 1200 degrees.

This type of drying oven is adapted for drying insulating paints, baking enamels, thorough drying of fire clay-asbestos balls used for determining temperature of furnaces, driving off moisture in samples of coal and for various other purposes constantly occurring to the physics teacher.

GEOLOGY OF OIL LITTLE UNDERSTOOD.

The principles governing the origin and mode of occurrence of petroleum and natural gas are as yet but fragmentarily grasped by geologists. Every oil field examined in detail contributes its data for use in the eventual interpretation of the problems, and each pool is studied with keen alertness for the discovery of some key that may aid in the coördination of the data, which sometimes, according to the region and conditions, seem, on account of our lack of knowledge, even to be in conflict. The observations made by the geologists of the United States Geological Survey in the oil and gas fields of California and Kentucky promise to further the solution of some of the problems, and by pointing out the relations of oil and gas occurrence to the geologic structure of the regions examined they have rendered important scientific as well as economic aid in oil and gas development; but the basic principles controlling the widely varied modes of occurrence and accounting for the differences in kinds of the oils in widely separated regions are possibly still far from view.

A SOURCE OF ACADEMIC INEFFICIENCY.[1]

An Educational Criticism.

By Arthur E. Haynes.

After an experience of five years as an undergraduate and nearly forty years in teaching, about thirty-seven of it in college, and after a cessation for a year and a half of the steady strain of the class-room, I think I am prepared, in some degree, to act the part of a just critic. Through all these years, both as student and teacher, I have been deeply interested in education including both the subject-matter and the methods of instruction.

At the close of my undergraduate work in a public address at commencement I stated as a result of my previous five years of experience and observation, that I was satisfied that too many studies were required of the student in a given time to make him efficient in any one of those studies. Since that event through more than a generation of time new studies have been steadily added to our curricula until they have become so overcrowded that they defeat the fundamental purpose of education. Too many studies in too little time produce confusion and lack of confidence on the part of the student. Too many lines of thought tend to distraction; they lead one nowhere; they do not develop the mind. The power of abstraction is the most important, the finest fruit of right education; it is not born of confusion; it is the child of painstaking, thorough, clear-headed, logical mental development.

The curricula of our schools, from the kindergarten to and including the university, are crowded beyond all reason and all hope of producing the best results. To be able parrot-like to recite rules and formulae is not education; walking through a botanical garden does not make one a botanist; it is that which the student *masters* that makes him a student; going through books does not necessarily educate one.

There is a great difference between one's going through a book and having the book go through him.

Too many studies in a given time cut off the time necessary for reflection—a prime essential to thoroughness.

Intensiveness is not the child of *extensiveness*.

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[1]Paper given before the Society for the Promotion of Engineering Education at Minneapolis, June 24, 1913.

One's scholarship is not measured so much by its *breadth* as by its *depth*.

The disciplinary and the cultural value of a course does not depend so much upon the number and kind of subjects in the course as upon the way in which it is taught and studied.

Like areas increase as the *squares* of their like dimensions, like solids as the *cubes* of such dimensions.

Why is there a great cry for efficiency at the present time?

It seems to me it is because education has been made a *stuffing* process, instead of a process of *evolution*.

The teacher is not so much to blame for this state of affairs as is the poor system under which he is working.

I venture the assertion that the time properly spent on one-half of the number of studies which are now required, would lead the student to a higher efficiency, to a thoroughness and to an independence in his thinking not now possible but altogether desirable.

Our whole system of education needs some heroic surgery, it should be subjected to a major operation. Have we the courage to begin this work? If so, I hope we shall not be slow in doing our best.

In conclusion may I quote from the excellent work by Hon. John M. Gregory, "The Seven Laws of Teaching." These are worth writing in every class room, in letters of gold.

(1) "A *teacher* must be one who knows the lesson on truth to be taught."

(2) "A *learner* is one who *attends* with interest to the lesson given."

(3) "The *language* used as a *medium* between teacher and learner must be *common* to both."

(4) "The *lesson* to be learned must be explicable in terms of truth already known by the learner—the *unknown* must be explained by the *known*."

(5) "*Teaching* is *arousing* and *using* the *pupil's mind* to form in it a desired conception or thought."

(6) "*Learning* is thinking into one's own *understanding* a new idea or truth."

(7) "The *test* and *proof* of teaching done—the finishing and fastening process—must be a *re-viewing, re-thinking, re-knowing,* and *re-producing* of the knowledge taught."

I heartily commend the book from which I quote the above

and also "Watt's on the Mind." Each of these was a great inspiration and help to me in my active teaching and each is worthy of careful reading and re-reading.

NOTE.—The first of these books is published by the Congregational House, Beacon St., Boston, Mass.; the second by A. S. Barnes & Co., Chicago, Ill.

FAMOUS BOOK COLLECTIONS IN AMERICAN LIBRARIES.

One of the world's best collections of books on Turkey and the Balkan states is in an American library. It is the famous Riant collection now in Harvard University library, and is interestingly described in a bulletin just issued by the United States Bureau of Education. It was acquired by Harvard in 1899 and has since been added to, until today the section on the Ottoman Empire comprises about 4,000 volumes.

American libraries have a very large number of valuable special collections. What is probably the most important Dante collection in existence is at Cornell, and the same institution has a collection on the French Revolution that experts say can hardly be surpassed even in France. The most remarkable set of Bibles in the world, comprising a large number of first editions and unique copies, is in the library of the General Theological Seminary in New York. New York City also has one of the most nearly complete collections of books on Hebrew subjects, that in the Jewish Theological Seminary, consisting of 33,000 volumes. One of the finest libraries of Japanese material to be found anywhere is at Yale University. In works on mystic subjects it would be difficult to duplicate in Europe the great collection in the Masonic Library at Cedar Rapids, Iowa, or the similar collection of books and manuscripts on ritual and ceremonial in the Massachusetts Grand Lodge of Masons at Boston.

For a great collection of works on German socialism the expert need not look to Germany; he can find it in the United States. At the Wisconsin State Historical Library, at Madison, is the Schlüeter collection, containing many works not found even in the archives of the German Social Democracy in Berlin.

In music the Newberry Public Library of Chicago has a conspicuous collection, especially rich in works on the history and theory of music by Italian authors.

On the side of science, the Carnegie Library of Pittsburgh contains about 40,000 volumes on the natural sciences and useful arts, and the Missouri Botanical Garden Library at St. Louis is especially rich in monographs and floras.

These are but a few of the many collections of world-wide significance that are in American libraries. The modern tendency in library-making, both among private and public collectors, is to concentrate on some one field or portion of a field, rather than to scatter. For this reason a list by subjects, showing just where the material on certain topics may be found, is peculiarly valuable to the serious searcher after knowledge. The bulletin, "Special Collections in Libraries in the United States," was compiled for the Bureau of Education by W. Dawson Johnson and Isadora G. Mudge, of Columbia University, and has been printed for free distribution.

CHICAGO GEOMETRY SYLLABUS.[1]

MABEL SYKES, *Chairman.*

PREFACE.

This syllabus lays no claim to completeness, nor does it intend to suggest any order in which theorems or groups of theorems may be presented. The syllabus has, however, two distinct aims, namely: to show the possibility of emphasis in presentation and of applications with a concrete setting.

Geometry should not be taught as one "dead level of monotony." A clear and lasting impression of a vast field can be obtained only through distinctions in emphasis. This is a fundamental characteristic of the human mind. It is hoped that by some such classification of theorems as is here indicated, the dependence of the minor theorems upon the more important ones can be clearly shown and that by careful choice and grouping of exercises the important theorems can be emphasized.

The outlines for concrete work and applications are intended to be suggestive only. It is hoped that each teacher will find therein abundant material from which to choose. While every teacher realizes the necessity of problems with concrete setting, it has until very recently been extremely difficult to obtain any variety of such problems. The references here inserted may prove a suggestive and helpful source of supplementary problems.

GENERAL SUGGESTIONS.

A. The following theorems may be assumed or proved informally:

1. Only one perpendicular can be drawn to a line from a given point, whether the point be within the line or without the line.
2. All straight angles are equal.
3. All right angles are equal.
4. Only one line can be drawn bisecting a given angle.
5. The sum of two or more angles on one side of a straight line having a common vertex is two right angles.
6. The total angular magnitude about a point is four right angles.
7. Complements and supplements of equal angles are equal.
8. Vertical angles are equal.

[1]This Syllabus was presented to the mathematics section of the high school teachers of Chicago sometime ago and by them presented to the superintendent of schools. Since issuing the report, some books have appeared which might have been added to the list of references, such as Betz and Webb Geometry, by Ginn & Co., and Source Book of Problems for Geometry by Mable Sykes, Allyn & Bacon.

9. Any side of a triangle is less than the sum of the other two.

10. If the sum of two angles is two right angles, their exterior sides form a straight line.

11. Only one parallel can be drawn to a line through a given point.

12. A perpendicular from a point to a line is the shortest distance from the point to the line, and the converse.

13. Circles with equal radii are equal, and the converse.

14. A diameter bisects the circle.

15. A straight line can intersect a circle at most in two points.

16. Angles at the center of a circle are measured by the subtended arc.

17. In the same circle or in equal circles, equal angles at the center subtend equal arcs, and the converse.

B. Constructions.

I. The ordinary simple constructions should be introduced from the beginning as needed.

II. Figures for theorems should be constructed according to the hypothesis and (except occasionally in blackboard work) should be constructed exactly. It is often desirable for the pupil to discover by measurements made on an accurate figure, facts and relations that serve as a basis for future theorems.

III. Original problems in construction should be attacked by special methods. Two such methods deserve special attention:

a. Method by analysis, such problems as:

1. Construction of triangles and quadrilaterals from given data. Those requiring the construction of auxiliary triangles may be introduced wherever possible, *e. g.*, construct a triangle A B C given the altitude and the median upon *a* and the side *b*. This may be given with the construction for a right triangle given the hypotenuse and a side.

2. Construction of lines, *e. g.*, construct a line that shall pass through a given point and make a given angle with a given line.

3. Construction of equivalent figures, where an algebraic analysis is used.

b. Method by intersection of loci. Such problems as the construction of triangles and circles, and the determination of points.

IV. References.

1. Wright, Exercises in Concrete Geometry (chapter on loci).

2. J. Petersen, Methods and Theories for solution of Problems in Geometrical Construction. Copenhagen. Translation may be obtained through G. E. Stechert & Co., New York.

3. Mahler, Ebene Geometrie; Part III, Leipzig.

4. Morris and Husband, Practical Plane and Solid Geometry.

5. Wentworth-Smith (Constructions classified).

6. Durrell, Plane and Solid Geometry.

7. Wentworth and Hill, Geometry Exercise Manual (Constructions classified).

8. Nichols, E. A., Elementary and Constructional Geometry.

9. Wells, New Plane and Solid Geometry. Gives directions for construction of figures according to the hypothesis.

First Semester.

A. Preliminary Concrete Work.

Note. These exercises are grouped here together for convenience. They may be scattered through the early part of the work as desired.

I. Test for straight edge (sighting).

II. Test for right angle; mechanics' test for square.

III. Measurements of lengths; use of dividers.

IV. Measurement of angles; use of protractor.

a. In constructing an angle of given size.

b. In measuring a given angle.

c. Approximate construction of regular polygons of any given number of sides by means of angles at the center of the circumscribed circle.

V. Problems requiring the solution of an algebraic equation and making use of the facts concerning complementary angles, supplementary angles, the angular magnitude about a point on one side of a straight line, and the total angular magnitude about a point. See Myers, Geometric Exercises; Wright, Exercises in Concrete Geometry; Wentworth-Smith, pages 19 and 24; Stone-Millis, pages 14 and 15.

VI. Construction of an angle at a given point in a given line, equal to a given angle (without protractor).

VII. Construction of a perpendicular bisector to a given line. Tests for accuracy. The perpendicular bisectors of the

sides of a triangle should be concurrent and the medians should be concurrent. Construct accurate figures.

VIII. Construction of a perpendicular to a given line from a given point in the line. Test for accuracy. If 10, 12 and 6 are the sides of triangle, the solution of the equations $x+y=12$, $y+z=6$, and $x+z=10$, will give the points of tangency of the inscribed circle. Locate these points and erect perpendiculars to the sides at these points. Inscribe the circle.

IX. Construction of perpendicular to a line from a given point without the line. Test for accuracy. The three altitudes of a triangle should be concurrent.

X. Bisecting a given angle. Test for accuracy. The bisectors of the angles of a triangle should be concurrent.

XI. Construction with concrete setting.

a. Tile patterns to scale. See any tile catalogue. All tiles are derived in some way from the six-inch square, and all tile patterns drawn to scale.

b. Ornamental figures based on square net works. See Diefenbach: Geometriche Ornamentik, Max Spielmeyer, Berlin.

c. Ornamental figures based on circles. See Diefenbach, or Wentworth-Smith, p. 11-12.

d. Construction of mechanical devices. Stone-Millis, p. 17 and 30-31.

XII. Construction of figures from simple problems. Wentworth-Smith, p. 13-14.

XIII. Preliminary work on construction of loci: *e. g.*, a chord of a circle moves so as always to pass through a given point. Find by experiment the path of its middle point.

XIV. Verification of Pythagorean proposition. The use of this theorem increases the amount of concrete work possible, especially in connection with the theorems on tangents.

Note. Eggar, Manual of Geometry, Macmillan, is suggestive on this whole topic.

B. Congruent Triangles.

I. Preliminary work.

Construction of various triangles from given data, followed by the tracing or cutting out and the super-position of such triangles.

II. Fundamental theorems.

a. Two triangles having two sides and the included angle, etc.

b. Two triangles having two angles and the included side, etc.

III. Important dependent theorems.

a. Two triangles having three sides of one, etc.

b. Theorems concerning isosceles triangles.

c. In the same circle or in equal circles equal arcs subtend equal chords and the converse.

d. Two right triangles having the hypotenuse and a side, etc.

e. Such of the theorems given below under arcs, chords, and tangents, as may be proved here if preferred.

IV. Applications.

Theorems and constructions depending on the above theorems. Simple problems in measuring inaccessible distances. Explanation of the use of triangular supports. For suggestions, see Stone-Millis, pp. 47, 48, Godfrey and Siddons, pp. 87, 88, 91, 115, 119. Slaught and Lennes, pp. 15-17. Experimental construction of loci.

C. Parallels.

I. Preliminary work.

Construction with draftsman's triangle and ruler, and with dividers and ruler, of two parallel lines, of a line equally distant from two parallel lines. Measurement with protractor of angles of parallels cut by transversals, to find all equal and all supplementary angles.

II. Important theorems.

a. Two lines parallel to a third line are parallel to each other.

b. Two lines perpendicular to the same line are parallel.

c. If a line is perpendicular to one of two parallel, etc.

d. Theorems regarding alternate-interior angles and exterior-interior angles, and the converse theorems.

III. Applications.

Theorems and construction depending on the above theorems. Arithmetical and algebraic problems based on facts established in the above. See Wentworth-Smith, p. 52, and similar exercises in all the newer books.

D. The Sum of the Angles of a Triangle.

I. Preliminary work.

Construct a triangle, and with a protector find the sum of the angles; extend each side in succession, measure each exterior

angle and find what two interior angles are together equal to it.

II. Fundamental theorem.

The sum of the angles of a triangle is two right angles.

III. Important dependent theorems.

a. If two triangles have two angles of one equal respectively to two angles of the other, the third angles are equal.

b. An exterior angle of a triangle equals, etc.

c. Theorems for the sum of the interior and exterior angles of polygons.

IV. Applications.

Theorems and constructions depending upon the above theorems. Accurate construction of figures for the above theorems and verification by measurement with protractor. Arithmetical and algebraic problems, based on the above theorems. See Wentworth-Smith, p. 52, 53. Wright: Exercises in Concrete Geometry, r. 5-9. Regular polygons and tiled floors. See Slaught and Lennes, p. 77-79.

E. Quadrilaterals.

I. Preliminary work.

Construct a parallelogram given two sides and the included angle; construction to be based on the definition of a parallelogram.

II. Important theorems.

a. A quadrilateral is a parallelogram if two opposite sides are equal and parallel, or if both pairs of opposite sides are equal.

b. The opposite sides and angles of a parallelogram are equal.

c. The diagonals of a parallelogram bisect each other.

III. Applications.

Theorems and constructions based on the above theorems. Exercises from parquet floor patterns. See Slaught and Lennes, p. 76-82. Experimental construction of loci; *e. g.*, a parallelogram ABCD has vertex A, and also the direction of sides AB and AD, fixed; find the locus of vertex C if the sum of the sides AB and AD is constant.

F. Arcs, Chords, and Tangents.

The theorems in this section may be given in connection with those under B, C, and D, or they may be grouped here.

I. Important theorems.

a. Radius perpendicular to a chord, etc., and the converse.

b. Equal chords are equally distant from the center.

c. Radius to the point of contact is perpendicular to the tangent and the converse.

II. Applications.

Theorems and constructions based on the above theorems. Construction of ornamental drawings based on circles; also architectural figures as easement cornices, moldings, various arches, etc. See Stone-Millis, Chapter on Circles; Godfrey and Siddons, first part of Book III; Slaught and Lennes, p. 92-94. Experimental construction of loci.

G. Measurement of Angles.

I. Preliminary work.

Draw various inscribed angles and a central angle that intercept the same arc; measure each with the protractor. Draw and measure several inscribed angles intercepting the same minor arc, several intercepting the same major arc, and several inscribed in a semi-circle.

II. Fundamental theorem.

An angle at the center of a circle is measured by its subtended arc.

III. Important dependent theorems.

a. An inscribed angle is measured by one-half its intercepted arc.

b. An angle formed by a tangent and a chord, etc.

c. An angle formed by two secants, a secant and a tangent, etc.

d. An angle formed by two chords, etc.

e. Parallel lines intercept equal arcs, etc.

IV. Applications.

Theorems and constructions depending upon the above theorems. Proofs by means of circles of various theorems previously proved otherwise; *e. g.*, the sum of the angles of a triangle. Construction for tangents from a point without a circle and for tangents to two circles. On a given straight line to construct a segment to contain a given angle. Problems from carpentry, pattern making, marine surveying, and railroad surveying. See Stone-Millis, Chapter on circles; Slaught and Lennes, pp. 107-111; Godfrey and Siddons, Book III, Angle properties; Breckinridge, Mersereau, and Moore, Shop Mathematics, pp. 68-71. Arithmetic and Algebraic exercises. See Myers Second Year Mathematics, pp. 137-139.

H. Loci.

I. Preliminary work.

The use of the word path instead of locus is recommended. Constructions of paths of moving points; this should be done by locating by construction a sufficient number of points to determine the nature of the path. A sufficient number of such constructions should be given to familiarize the class with the idea of motion. These exercises may be introduced from the first and scattered along as they apply.

II. Proofs for very simple theorems may be omitted or given informally, *e. g.*, Locus of all points at a given distance from a given point, or at a given distance from a given line.

III. Formal proofs for important theorems.

In all such proofs, the two-fold idea involved should be clearly understood.

a. Locus of all points equally distant from two given points.

b. Locus of all points equally distant from the sides of an angle.

IV. Applications.

a. Construction of inscribed, circumscribed and escribed circles.

b. Construction of circles and triangles and determination of points.

c. Theorems concerning concurrent lines in triangles.

d. Problems with concrete setting, *e. g.*, reversed curves, easement curves, etc. See Stone-Millis, p. 160; Trefoils and Gothic windows; Slaught and Lennes, p. 93-94, 101 and 108-110.

I. Inequalities (optional).

I. Preliminary work is hardly necessary. It might be worth while to have pupils measure the sides of some triangles and compare so as to discern the relation of any side to the sum of the other two.

II. Fundamental theorems.

Any side of a triangle is less than the sum of the other two.

III. Dependent theorems.

a. If two sides of a triangle are unequal the angles opposite them are unequal, etc., and the converse. The perpendicular is the shortest distance from a point outside a line to a given line.

Of two unequal oblique lines from a point in a perpendicular the more remote from the foot of the perpendicular is the greater, and the converse.

b. If a perpendicular be erected at the middle of a straight line, the distance from any point not in the perpendicular, etc.

c. Two lines from a point in a triangle to the extremities of one side are together less than, etc.

d. If two triangles have two sides equal and the included angles unequal, etc., and the converse.

Chords subtending unequal arcs are unequal, etc., and the converse.

IV. Concrete applications.

A few arithmetical and algebraic problems may be given.

Second Semester.

A. Equal Ratios and Parallels.

I. Preliminary work.

a. Measurement of lines; possibility of incommensurable lines; approximate ratios; H. C. D. of two lines. Draw two lines, measure in inches and sixteenths of an inch, find the ratio of the lines; measure the lines in millimeters and find the ratio; find the ratio by H. C. D. These ratios should agree to the third decimal place.

b. Construct a line parallel to the base of a triangle. Find approximate ratios of segments and sides.

II. Fundamental theorem.

If a series of parallels cut off equal segments on one transversal, etc.

III. Important dependent theorems.

a. A line parallel to the base of a triangle divides the sides into segments that have the same ratio, and the converse.

b. Parallel lines cut off proportional segments on any two transversals.

IV. Applications.

a. Constructions dependent on the above: constructions for third and fourth proportionals and for dividing a line into parts proportional to any number of given parts.

b. Numerical and algebraic problems. See Wentworth-Smith, p. 159; Short and Elson, pp. 174, 180.

B. Equal Ratios and Similar Figures.

I. Preliminary work.

Construct two mutually equiangular triangles and find the approximate ratios of corresponding sides; these ratios should agree to the third decimal place.

II. Fundamental theorem.

If two triangles are mutually equiangular, corresponding sides have the same ratio.

III. Important dependent theorems.

a. Two triangles are similar if corresponding sides have the same ratio, or if two pairs of corresponding sides have equal ratios and the included angles are equal.

b. The ratios of corresponding lines of similar polygons are equal; *i. e.,* corresponding altitudes of similar triangles.

c. Important cases of equal ratios: In a right triangle the altitude upon the hypotenuse is a mean proportional, etc.

IV. Applications.

a. Theorems dependent upon the above, especially theorems in which it is required to prove two ratios equal. The usual methods of proving two ratios equal should be emphasized.

b. Constructions dependent upon the above. Fourth proportionals, mean proportionals, and similar figures.

c. Definitions of sine, cosine, and tangent; problems in heights and distances. See Stone-Millis, pp. 82-99; Slaught and Lennes, p. 137; Short and Elson, pp. 193-203.

d. Numerical and algebraic problems. See Stone-Millis, p. 179; Wentworth-Smith, pp. 176 and 187; Short and Elson, p. 188; Slaught and Lennes, pp. 140-144; Myers II, pp. 28-34, p. 52; Wright, Concrete Exercises in Geometry, pp. 14-20. Algebraic work should be emphasized here. Review of quadratics and radicals is advised.

e. Drawings to scale, diagonal scales, etc. Stone-Millis, p. 80.

C. Areas.

I. Preliminary work.

By using squared paper and also by drawing and cutting out the figures the equivalence of various parallelograms having equal bases and equal altitudes may be shown. This may be done with triangles. In various ways the truth of the Pythagorean proposition may be illustrated, *e. g.,* Penrigals dissection.

Squared paper may be used to advantage in work on areas. Estimating is also valuable.

II. Fundamental theorem.

The area of a rectangle equals, etc.

III. Important dependent theorems.

a. Measurement of areas.

1. The area of a parallelogram equals, etc.
2. The area of a triangle equals, etc.
3. The area of a trapezoid equals, etc.

b. Comparison of areas.

1. Pythagorean proposition.
2. The areas of similar polygons have the same ratio as the squares of homologous sides.
3. Parallelograms and triangles having equal altitudes, equal bases, or equal altitudes and bases, etc., are to each other, etc.

IV. Applications.

a. Constructions depending on:

1. Parallelograms and triangles having equal bases and equal altitudes.
2. Pythagorean proposition.
3. Algebraic analysis.

b. Theorems depending on the above, *e. g.*, proving areas equal by equal bases and altitudes, or by the sum of congruent or equivalent parts.

c. Surveyor's method of finding areas of plats irregular in outline.

d. Numerical and algebraic problems involving Pythagorean and other propositions including areas of various polygons. The algebraic work is of special importance. Review of radicals and quadratics is strongly advised. For suggestive exercises see recent texts in algebra and geometry.

e. Graphic representation of square roots.

f. Geometrical illustration of algebraic identities, and numerical illustration of identities on squared paper.

Note. Much suggestive material may be found in the chapter on areas in Godfrey and Siddons, Elementary Geometry. Also Myers, Second Year Mathematics, Chap. IV; Stone-Millis, Chap. X. and XI; Wentworth-Smith, Chap. IV; Slaught and Lennes, pp. 170-175.

D. Inscribed and Circumscribed Polygons.

Note. The object of this series of theorems is the measurement of the circle. Theorems involving theory of limits may be proved informally without theory of limits. Stress should be laid on the fact that the numerical results are only approximate.

I. Fundamental theorems.

1. An equilateral polygon in a circle is regular.

2. A circle can be circumscribed about or inscribed in a regular polygon.

3. If a circumference is divided into equal parts, tangents through the points of division form a regular circumscribed polygon.

4. Regular polygons of the same number of sides are similar.

5. The area of a regular polygon equals one-half the product of its perimeter and apothem.

II. Dependent theorems.

a. The ratio of perimeters of two regular polygons.

b. The apothem of a regular inscribed polygon as a variable.

c. The perimeter and area of such polygon as variables.

d. The ratios of the circumferences and areas of two circles.

e. The ratio of the areas of two similar segments.

f. The area of a circle equals one-half the product, etc.

g. A side of a regular hexagon equals the radius, etc.

h. To find the side of a regular inscribed polygon of double the number of sides, etc.

i. To compute the value of π.

j. Problems for constructing regular polygons of three, four, five and six sides, and of two, four, eight, etc., times as many sides.

III. Applications.

Probably those most worth while are arithmetical and algebraic problems involving the above theorems. As many of these as are desired can be selected from recent textbooks, in which they are numerous.

THE CAUSE OF WINDS; AN INDUCTIVE STUDY.

By R. R. Turner,
University of Illinois.

1. As a basis for study, *map the winds of the U. S.* for a given day, on blank weather maps. Represent by arrows flying with the wind, the lengths proportional to the velocities. Do not use numbers to represent velocity.

This may be introduced as a purely local problem: On Feb. 1, 1908, the wind here was blowing strongly and steadily from the northwest. Why? The meagerness of data suggests a nation-wide map.

The details of the discussion below refer to the map named; but any map may be used which clearly shows the principles.

2. In discussing the map, bring out

(a) Light winds all over the West, blowing outward in all directions, merging into

(b) A strong southeastward movement over the Mississippi Valley, this in turn, is part of

(c) A general strong movement toward a center in or about Michigan; the latter almost masked by

(d) Decided spiral whirl throughout the East.

3. In searching for *reasons,* it should be easy to elicit the suggestion that because the air in the west is "heavier," it may be "squeezing out" air in all directions: that similarly there must be, in the northeast, a region where the air must be "lighter," or rising, and hence sucking in the air from all sides, as the light air above a bonfire does. (Guard against implying that the low pressure is due always to heated air.)

It would be well just here to suggest that the strong swirl is like that seen when water is coming together from all parts of a basin to an opening in the center.

4. This suggests an inquiry into the "heaviness" or pressure over the U. S. for that day. Record at each station the barometric pressure (which the teacher can easily read from the published weather map). This is better done on the same map.

5. The generally high pressure in the West, and low pressure in the East, will at once indicate some relation, as suspected, between pressure and winds. Draw a line between the "high" and "low" regions. Discuss its nature; draw a few more like it; compare with *isotherms*; call them *isobars*. Draw iso-

bars for every $\frac{1}{10}$ inch, beginning at the "High" and "Low" centers.

General principle that winds are movements of air from high pressure to low pressure, trying to equalize pressures, stated.

6. How would the wind blow if this were the only determining element? Shortest and most direct path to lower pressures; idea of "barometric gradient." Discover general *deflection to the right*; show relation to rotation of earth. Illustrate by marble rolling on rotating disk, or by chalk marks on rotating globe.[1]

7. To show the *generality* of the data from which the conclusions are based, trace, on "onion-skin" paper (2-½"x2-½") the winds about cyclones and anticyclones on many weather maps.

[1]See Dryer, Lessons in Phys. Geog.

TRACHOMA.

This disease of the eyes is becoming of greater importance as it becomes more widespread throughout our country. In 1897 the Secretary of the Treasury declared trachoma a dangerous contagious disease, and denied an immigrant afflicted with it entrance to this country, because of the discovery that the disease was being introduced and disseminated by immigrants. It seems to be undisputed that no country is free from the ravages of the disease, the history of which goes back to ancient times, and that no race is immune from it and no age exempt, except the very young. The cause of trachoma is not yet known, as the specific germ has not yet been discovered. The disease occurs in groups, in localities, in houses, in factories, and in schools, and is spread by contact or by contamination with articles like common towels, which are handled by the afflicted patient and his fellows.

The seriousness of trachoma, its contagiousness, the knowledge that thousands of would-be immigrants are waiting to come to America if restriction of this disease is removed, the amount of it already in this country, and, especially, its concentration in certain localities, mean that measures for its prevention should be inaugurated by every state, city and town where the disease has been discovered. Poverty, crowding, dirt and articles used in common tend to spread this infection rapidly. While the number of persons having trachoma may be diminishing in some of our larger cities where both the government and the local authorities are alert to the danger of the disease and to the segregation necessary, other cities and communities should pass such ordinances as would cause every case of trachoma to be reported. School children should be inspected for this disease. Factories should also be inspected, and where the disease is discovered the owners should take measures to prevent its spread and to eliminate it if possible. A person with trachoma should be isolated and treated until he is well. A child who is discovered to have trachoma and is banished from school should be followed to its home by a visiting nurse or some inspector from the board of health to insure that the child does not spread contagion in its own home. School washrooms should have faucets for running water which are controlled by foot-pressure, so that the hands need not touch the faucets. The common towel should be abolished with the common drinking cup. These rules for cleanliness apply also to factories, hotels, office buildings and all public institutions.

THE RELATION OF FIRST YEAR SCIENCE TO COURSES IN AGRICULTURE.[1]

By Charles A. Shull.
University of Kansas, Lawrence.

The problems which confront us as educators are nowhere more complex and difficult of solution, I take it, than those which we meet when we come to the introduction of vocational subjects into the curricula of our secondary and primary institutions. There is an insistent demand on the part of the patrons of our schools, that education shall contribute as fully as possible to the vital physical needs of the future citizen, that it shall fit him for life and citizenship of a very high order; that it shall quickly enable him to enter a vocation and earn therefrom a competence for home and family—a demand which is strong because it has in it the spirit of elemental justice to the young, and of democracy in opportunity.

However, the demand brings us face to face with a historical fact from which we cannot get away. Applied science is new. It is the most recent development of scientific endeavor, and is the outgrowth of pure science which has always preceded it. Without exception the commercially most important discoveries, the most practical applications of knowledge, have always been preceded by the discoveries of pure science; and they cannot rightly be understood until the parent discoveries are comprehended fully. Speaking in terms of biological analogy, pure science stands phylogenetically first; applied science is the later evolution. The logical ontogeny of the scientific development of the pupil should repeat the phylogeny, and the applied science should be learned only when a sufficient basis of pure science has been laid for his advancement in practical fields. No student, for instance, can be a productive electrical engineer until he has mastered his mathematics, and the principles of magnetism, electricity, electrical conductivity, etc. This fundamental condition is just as true of agricultural science as it is of any other. And yet, we are trying to take short cuts in this ontogeny, trying to force the vocational studies, the applied sciences, farther and farther back, even to the grades, in the hope, apparently, that somehow or other the larval productive man may be enabled to change suddenly into a butterfly without having to pass through

[1]Read before the Tenth Annual Conference of Kansas High Schools and Academies at the University of Kansas, Lawrence, 1913.

the pupal stage—a stage of preparation for strong and sustained flight. The whole matter seems to me at times quite contrary to Nature's plan.

Moreover, the difficulties are bound up with the limits of efficiency of our educational machinery, and with the limitations of the mental capabilities of the boys and girls, and the young manhood and womanhood found in our institutions. If vocational studies are to be introduced not only into the high school, but even into the grades, is there any possibility that the work may be overcrowded? Can the child take on many more subjects, and can the teacher teach many more kinds of knowledge without overcrowding the whole system until both mental and pedagogical efficiency is impaired? Shall we allow all phases of our educational work to suffer, shall we have all subjects poorly taught and poorly learned simply from overloading the curriculum? No one desires such a result, least of all those who make the demands for vocational training in primary and secondary schools.

How, then, shall we maintain efficiency in education and yet do all that is asked of us? It seems to me obvious that little now taught in the grades can be safely omitted and replaced by vocational training. Shall we then lengthen the time of preparation by increasing our eight grades to nine or ten? Such a policy is not in line with the present tendency in education, which is toward shortening the time of preparation for entrance upon productive life work, rather than lengthening it. A man fully prepared in these days has given half his life before he begins to work, and one-third to one-fourth of his best protective years are past. The only expedient left which offers promise is a lengthening of the school year, which is strongly advocated in some sections, until it embraces all but a few weeks of the year. But even here the efficiency of the teacher for so long a school year becomes a problem.

The difficulties which beset us, then, are very real, and should be well considered when we come to place additional subjects in our curricula. Provision should be made which will insure the permanent efficiency of all parts of the system whenever such changes are introduced. Such provision being made, I see no reason why we should not have as much vocational training as our young people can be properly trained to carry with advantage.

In an agricultural state like this, perhaps in any state, the

fundamental applied sciences are agriculture and home economics. These are basic in the welfare of any people and with justice may be urged as by far the best vocational subjects for our high schools.

It is my purpose to discuss as fully as time permits the relation which agriculture may have to the first year science of the high school, as well as to the more advanced science courses. Several questions at once suggest themselves for discussion. (*a.*) What kind of preparation should precede the agriculture? Of what should the prerequisite science consist? (*b.*) Where in the high school course should agriculture be placed, early or late? And the answers will depend largely upon the answers to a third question, (*c.*) What is the real purpose of teaching agriculture in the high school? There are several quite different reasons urged for this teaching, depending largely, it seems to me, upon the personal relation of the one who answers the query to the whole business of education.

It will be logical to answer these questions in reverse order, and consider first what is the real purpose of vocational training. If the person who answers the question is pedagogically inclined, and has experienced the difficulty of securing the student's interest in pure science, he is likely to look upon it as an expedient means of getting the pupil to realize his needs; as a means of interesting him and keeping him interested in the educational process; as a lure to the somewhat less practical fields of physics, chemistry, and biology, and a leading string thereby to college and university education. But the school patron is demanding vocational work as preparation for productive life work. He makes a plea for something that shall be commercially useful, and not merely aesthetic; for something, in the rural states, which will make it less than necessary for the boy to take up life in the city. If it is to be really useful in this way, education must be thoroughly accomplished.

As previously suggested, the plan to use applied science as a basis for pure science later is quite illogical, in that it completely reverses the natural order of things. Agriculture, if properly presented, if it is to be worthy to be called a science, is so complex as to demand a training unusually full and complete. The successful agriculturist must understand the causes of soil fertility and soil sterility, which is an exceedingly complex subject. It means that he must know the physics and chemistry of soil

textures, the relation of surface forces to water content and water movement in soils, and the relation of all these to plant growth. He must know something of the nature of colloids and their flocculation and deflocculation. He must know the mineral needs of plants, the special rôle of each mineral, how to detect the absence of any of them, and how to secure in the best way for the plant, all its physiological needs. He should know something of the biological factors in soil fertility, the bacterial and protozoan life of the soil, the organic constituents of soils, and the effects of poisonous organic root secretions. And he must know something of the effects of fertilizers upon all of these complexly interacting factors.

The successful agriculturist must know the principles of dairy bacteriology; he must know something of the chemical values of food stuffs; he must know the principles of animal and plant breeding, which requires biological training of a very high order. Furthermore, the relations of insects and fungous diseases of plants to agriculture, with methods of combating these enemies must occupy an important place in the work.

In short, every field of biological and physical science contributes to the making of agriculture, and if the agriculture course is to be thorough, if it is to be really scientific, then the preceding scientific course should give unusually full preparation.

To give such a course as a lure to pure science would be to make the student a muddle-headed idiot about the whole matter; and to teach agriculture in any less thorough manner would be to fail to meet the demand that it should actually prepare for active and serious life work.

To my mind, service should be the keynote of purpose for every course given, and I feel that the school patron is right in demanding preparation which is most useful in life's struggles and life's victories. We do not need to fear that all of the students will drop from the educational system on completion of such a course. Rather, I believe a larger percentage would go to the college and university as the result of such training, than now enter them. If the high school furnishes a *small* tool with which to carve one's way to successful life, college and university will naturally be expected to enlarge and sharpen the tool. But if the high schools fail, what is to be hoped for from further study?

I would therefore have scientific preparation for agriculture precede it, not use the vocational work as stimulators to other

fields. The kind of agriculture which can be used in this way is so elementary as to be useless in real life.

Granted, then, that the teaching of agriculture has a more serious mission in the course than a mere pedagogical device, granted that it is to provide as thorough preparation for farming as can be given in one year, where in the course should it come, early or late?

It would come early in a pedagogical device. It must come late to be of the greatest usefulness in real life. For it matters not whether the student goes from the high school to the farm or to the agricultural college. In either event it is better that his work along this line be uninterrupted after it is once started. The older mind is better able to grasp the fundamental principles upon which permanent agriculture must depend, and it will at the same time make a much better application of these principles if they are put into operation at once, while fresh in mind. It seems to me therefore, that the strategic time for the course in agriculture is during the last years of the high school curriculum. If the boy *must* stop his education at this point, he is as well prepared to engage in farming as the high school in a beginning course can make him; while if he can go farther he has had the best possible training for appreciative use of the enlarged opportunities afforded by the state agricultural college.

With this staging of the course in agriculture in the last year of the high school, what preparation will best meet the needs of the student? Naturally we have a right to expect and demand that the preparation really prepare for this work. And since agriculture is so complex in its make up, the preparation must be many sided. Botany, zoölogy, physics, and chemistry are all seriously involved, and no preparation can be called by any means adequate which does not present the practical principles of these four sciences. Of course, if agriculture is to be merely a teaching device, no knowledge except the familiar phenomena of country life, coupled with a healthy inquisitiveness and a good pair of eyes, is necessary. But I want to say emphatically that the kind of agriculture which can be taught on such a basis is so elementary that it will have no uplifting effect on agricultural practice. The farming of the next generation would be on about the same level as that of today. Such a result from our teaching of agriculture would be a pitiable commentary on our educational sense and foresight.

I must frankly confess that the preparation which I believe necessary for the course in agriculture cannot be given in any single year of science in the high school. A year of general science would not be sufficient. Less adequate still, perhaps, would be a single year in general biology, or a year in zoölogy or botany. Each of these subjects contributes to the preparation, and that preparation is very valuable and desirable; but one year of science, all told, is not enough. Plants of perennial growth rarely come to fruition in a single season.

The difficulty here lies in the fact that, whereas scientific affairs in the real life of the agriculturist will occupy a very large percentage of his time, we are giving to science in the high school a minimum of time—two years—one year of biological and one year of physical science being the usual requirement.

In accordance with the importance of science in life, a full four or five year course in science would not be too much for the high school, the training being differentiated for the two sexes. The boy's preparation should lead directly toward agriculture in an agricultural state, the girl's preparation toward household economics, sanitation, the beautification of buildings and grounds, etc. This course in science might begin perhaps best with some biological work, although there is some reason for presenting the physical science previously to the biological work. The character of the work given in the first year of biology is a much disputed question, and I sympathize with the ideals of those who prefer a year of zoölogy or a year of botany. I realize the difficulties involved in half year courses; or in combination courses called general biology. The tendency is to lower the quality of the work done. The trouble may lie partly in the fact that there has been no well developed central coördinating principle in any of the texts on general biology. They are usually a hit or miss hodgepodge of more or less relevant information, oftentimes indeed of erroneous misinformation.

The point in which plants and animals most nearly agree is in their physiology. And if zoölogy and botany can ever be successfully combined for a one year course, it must be on the basis of the similarity of organic functions in the two fields. I believe that a consistent and coherent year of biology might be developed along this line which would admirably meet the needs of the high school student. I disclaim at once any desire to have physiology taught without an understanding of morphology, for I would

consider that a serious mistake. But it is not necessary to study morphology apart from physiology in the high school. Instead of studying structures, and learning incidentally what functions they perform, we would study functions, which are essentially alike in animals and plants, and learn about all the structures in both kinds of organisms concerned in the functional process. While the separation of morphology from physiology is undoubtedly best for the college or university, where the development and differentiation of each subject has gone far, and where large theoretical problems press for consideration, in the high school this separation is unwise, and structures are best understood when viewed through physiological glasses. A more coherent course in general biology can be built around general physiology than around any other coördinating principle. And since in agriculture especially crop production and successful animal husbandry depend upon meeting the physiological needs of plants and animals, the prerequisite biology should deal much with this side of organic life.

This year of biology might well be followed by a year of physics, or vice versa if physical science is presented first, and a year of chemistry.[2] These physical sciences need further humanizing to bring them into more intimate contact with the real problems of life. The texts usually discuss diffusion, solution, osmosis, capillarity, and chemical reactions, not from the standpoint of the environment of living organisms, but as purely scientific phenomena, unrelated to the affairs of life. When gases diffuse, why not into or out of a leaf as well as in a glass vessel? When solutions are under discussion, why not a soil solution in contact with root hairs? When capillarity and surface forces form the subject, why not the capillary action of minute soil particles and organic bodies, as well as of hair-like glass tubes? When catalysis is under discussion, why not the catalytic action of enzymes in vital processes, along with manganese dioxid in the liberation of oxygen? There would have been small demand for a change in the science taught in the high schools if that taught during the last twenty years had been humanized and made practical from some other, as well as from the aesthetic and cultural standpoint. It is the demand for something more than mere polish that we are trying now to meet.

[2]The writer suggests that five units of science is about as small a number as will provide *adequate* preparation. The general biological and general physical science courses might then be given side by side in the first year of the high school course.

Those who are familiar with that presentation of the value of science in education which Herbert Spencer gave us a short time before his death, need fear nothing from the humanizing of our sciences. They will become of greater and greater disciplinary value as they become more and more useful in the regulation of conduct in life.

I would therefore have the preceding years occupied with biology, physics, and chemistry, all of which touched directly those principles underlying agriculture, and would have the teachers of these subjects so conversant with the relations of their sciences to agriculture that they could continually give intelligent direction of the student's interest toward rural scientific problems. It is an interwoven course of this kind that builds the right sort of education and retains the interest of the youth; and it is the enthusiastic personal interest of the teacher in the future work and progress of the boy that leads him on and on to the highest preparation for usefulness.

The objection may be raised that so much time, one-fourth or more of the high school course, cannot be devoted to science. To that I answer that from its importance to life, science deserves that amount of time, even if we have to give up some of our educational fetishes along other lines.[3] Moreover, several years ago, an important educational committee published a little pamphlet entitled "What Constitutes a High School Course?" in which the four year science course was recommended. All that we are asking is that the high school should offer such a four year course with agriculture in the final year or years, side by side with the other courses, with an elective system to suit all students, as has recently been done by Colebrook Academy, in New Hampshire. For the student who does not desire to take agriculture the first two or three years of the course would still prepare for future work in botany, zoölogy, physics, and chemistry. But the agri-

[3]Several years ago I suggested in a letter published in this magazine that a change should be made in the teaching of Latin in the high school. Time has served to confirm the opinion there expressed. The Latin which is worth while is that which enables the student to understand the origin and meaning of English words; but it is a mistake to spend three or four years in obtaining a minimum of worth-while Latin. If an elementary course in English origins were taught as part of the English requirement, replacing a part of the overdone study of English literature, a better grade of English scholarship would undoubtedly result. And by requiring all teachers of English to be familiar with Latin in order to be able to teach this "Latin-in-English" course, the Latin departments of our colleges and universities would be placed upon a much more permanent basis than at present, a basis of real usefulness. The Latin would then be taught in the high school English course for its real value, not for any fictitious value from the mere fact that it *is* Latin. The units vacated in the curriculum by this change could not be better used than in increasing the time devoted to sciences, which will prepare for useful as well as cultured citizenship.

cultural student should not be permitted to omit any of the preceding sciences.

While the standard set here for agricultural training in the high school is high, it can be attained if we really care to attain it. Let us not deceive ourselves about the importance of right agricultural training. Agriculture is the science of soil fertility. Every region which man has yet cultivated has deteriorated under the impoverishing and exploiting methods he has used; whereas agriculture by the very origin of its name should be the culture of the land itself, as well as of crops. Our fields should come into more perfect condition as time goes on; the soil should grow ever more rather than less fertile. Years ago the average production of corn in Douglas County was forty bushels per acre in a good year. Now it is not over thirty-five bushels per acre under the most favorable conditions, often not over twenty-five bushels per acre average. The same story is told by all exploited regions. Why should we not have increased the average yield to fifty bushels per acre instead? That such results could have been attained by better scientific methods of agriculture is shown by the fact that in our corn contests almost any boy by following improved methods of culture, soil management, and soil amelioration, can raise more than fifty bushels of corn per acre in almost any region of the state. The kind of agriculture now in practice is certainly not sufficient for the future. Agriculture must conserve and increase the value of our lands. We must create and maintain perennial fertility through generations of high crop yield, and have our fields always as productive, and as capable of sustaining the world's increasing population for other centuries of human progress. In other words, agriculture must become permanent, and be on the up grade.

And what of the agriculturist himself? Is he to depend perpetually on the government for all of his advancement? The purely scientific investigations of the government, and the applications of the results obtained, have been of untold value. But if properly trained the scientific farmer can do more than follow in a mechanical way the directions of the Bureau of Soils, or of Plant and Animal Industry. He can go beyond the carrying out of the advice of farm experts, or the imitation of the work on state demonstration farms. He must become himself a farm expert; his farm must become the demonstration of his own intelligent industry.

Every field and every crop for every season is a problem in itself. The successful husbandman must be able measurably to work out his own salvation, to meet the new problems which constantly arise, and to succeed by his own, not borrowed, intelligence. Every farm is an experiment station. Why should not its owner, the director of the station, have the physical equipment and the mental equipment to test his own soils? Why not a soil laboratory on every farm ultimately? Why not the farmer improve his own breeds of animals and plants? Why not know how to combat the already known and controllable insects and plant diseases without any expert advice? To me, this intellectual independence, this emancipation of the agriculturist is very important to the welfare of the whole human family. There will be no question as to the future of the world's food supply, nor as to the contentment of the great mass of people in agricultural pursuits if we can ever bring such conditions into existence by education.

I have tried to make my position clear. Agriculture is a serious occupation requiring serious preparation. Those who believe that nature study in the grades, or that an elementary course in agriculture without preceding scientific study can meet the demand for vocational life preparation are not acquainted with the complexity of the problems, nor do they comprehend the depth of the science needed in agriculture at the present time. The plan I have outlined here I believe would secure from the high school all of the benefits which the high school can possibly contribute. The agricultural colleges lie beyond.[4]

[4] At the close of the session the suggestion was offered by Dr. John G. Coulter that choice of future vocation and preparation for it should occur at the middle of the high school course; and in case the student decides to go directly from the high school to agriculture, rather than to the agricultural college, that he be given a two-year course in agriculture during the last two years of the high school.

The results of such a plan should be wholly beneficial provided adequate scientific training can be given during the first two years. By presenting the general biological and physical sciences side by side in the first year, and chemistry in the second —a five unit course—the requisite training could no doubt be provided.

On July 23rd an expedition for the study of marine biology, under the direction of the Carnegie Institution of Washington, set sail from San Francisco for Thursday Island, Torres Straits, Queensland, Australia. The party consists of Dr. Alfred G. Mayer, director, and Professor Hubert L. Clark, D. H. Tennent, E. N. Harvey, F. M. Potts, and Mr. John Mills.

The quantity of coal used for coke making in the United States in 1912 was 65,485,801 short tons, according to the United States Geological Survey. The coke produced from this coal amounted to 43,916,834 short tons, valued at $111,523,336, besides large quantities of gas, tar, ammonia, ect., as by-products from the 11,048,489 tons of coke produced in by-product ovens.

PROBLEM DEPARTMENT.

By. E. L. Brown,
Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

339. *Proposed by A. Babbitt, State College, Pa.*

Solve: $4x^4-16x^3+27x^2-21x+9=0$.

Solution by William W. Johnson, Cleveland, O.

Multiplying the roots of the given equation by 2, we obtain

$$y^4-8y^3+27y^2-42y+36=0. \qquad (1)$$

Diminishing the roots of (1) by 2, we obtain

$$z^4+3z^2+2z+12=0. \qquad (2)$$

Assume $z^4+3z^2+2z+12=(z^2+Az+B)(z^2-Az+C)$. (3)

Expanding and equating coefficients, we obtain

$$-A^2+B+C=3. \quad AC-AB=2, \quad BC=12. \qquad (4)$$

From (4) we get

$$A^6+6A^4-39A^2-4=0. \qquad (5)$$

By the factor theorem, we find $A^2=4$. $\therefore A=\pm 2$.

From (4) we now find $B=3$, and $C=4$.

Now $z^4+3z^2+2z+12=(z^2+2z+3)(z^2-2z+4)=0$.

$\therefore$ $z=-1\pm\sqrt{-2}$ and $1\pm\sqrt{-3}$,

$y=1\pm\sqrt{-2}$ and $3\pm\sqrt{-3}$,

and $x=\dfrac{1\pm\sqrt{-2}}{2}$ and $\dfrac{3\pm\sqrt{-3}}{2}$.

340. *Proposed by H. E. Trefethen, Waterville, Maine.*

$(\underline{|n-1})^2>n^{n-2}$. Prove.

I. *Solution by Elmer Schuyler, Brooklyn, N. Y., and W. J. Risley, Decatur, Ill.*

$$n>\left(1+\frac{1}{n}\right)^{n-1} \text{ or } 1+\frac{n-1}{n}+\frac{(n-1)(n-2)}{n^2\,\underline{|2}} \quad . \ . \ . \quad +\frac{1}{n^{n-1}},$$

since each term is less than or equal to unity.

$$\therefore\ n^n>(n+1)^{n-1}.$$

If $(\underline{|n-1})^2>n^{n-2}$ for n, then $(\underline{|n-1})^2\cdot n^n>n^{n-2}\cdot(n+1)^{n-1}$ or $(\underline{|n})^2>(n+1)^{n-1}$; that the inequality holds for $(n+1)$. Clearly it holds for $n=3$ and hence for $n=4$, and finally for any value of $n>2$. The inequality does not hold for $n=1, 2$.

II. *Solution by F. Eugene Seymour, Trenton, N. J., and R. M. Mathews, Riverside, Cal.*

Multiplying both sides of the inequality by n^2, and then dividing both sides of the resulting inequality by n^n, we are now required to show that

$$\frac{(\underline{|n})^2}{n^n}>1.$$

Since $(\underline{|n})^2=[1\cdot n]\cdot[2\cdot(n-1)] \quad . \ . \ . \quad [k\cdot(n-k+1)] \quad . \ . \ .$ $[n-1)\cdot 2]\cdot[n\cdot 1]$, we are asked to show that

$$\frac{[1\cdot n]}{n}\cdot\frac{[2(n-1)]}{n} \quad . \ . \ . \quad \frac{[k(n-k+1)]}{n} \quad . \ . \ . \quad \frac{[n\cdot 1]}{n}>1.$$

Since the first and last terms of this product are unity, our statement will be proved if we can show that each of the other factors is an improper fraction, *i. e.*,

$$\frac{K(n-k+1)}{n} > 1.$$

or that $k(k-1) < n(k-1)$

or dividing both sides by, $k-1$ which does not equal zero, $k<n$, which is manifestly true, since $k=n$ only for the last term.

Geometry.

341. *Proposed by L. M. S., New York City.*

From the vertex of a triangle draw a line to the base so that it may be a mean proportional between the segments of the base.

Solution by M. J. Schucker, Pittsburg, Pa., and I. L. Winckler, Cleveland, Ohio.

Let ABC be the given triangle. Let O be the center of the circumcircle. On OC as a diameter describe a circle. This circle may intersect AB in two points, be tangent to AB, or not intersect AB. If this circle intersects AB in two points say E and D, then there are two solutions, CE and CD; if tangent to AB, there is one solution; if it does not intersect AB and is not tangent, there is no so'ution. But a tangent to the circle at C intersecting AB, produced at K, is a solution, dividing AB externally.

Suppose CE, produced, cuts the circle at H.

Then $CE \times EH = AE \times EB$ or $\overline{CE}^2 = AE \times EB$.

Similarly $\overline{CD}^2 = AD \times DB$.

Also $\overline{CK}^2 = KB \times KA$.

342. *Proposed by Ernest B. Lytle, Urbana, Ill.*

To find a point in a plane such that the sum of its distances from two points on the same side of the plane shall be minimum.

I. *Solution by Wm. B. Borgers, Grand Rapids, Mich., and Harry Roeser, Stillwater, Okla.*

Through the points, P and Q, draw the plane perpendicular to the given plane, intersecting the given p ane in line AB, where A and B are respectively the projections of P and Q on the given plane. We shall first prove that the required point lies in AB. If possible, suppose it to be some other point, C. Draw CD perpendicular to AB at D. Then PD, QD, are perpendicular to CD, and are therefore less respectively than PC, QC. Hence any point outside AB cannot fulfill the condition, but the required point is some point E, in AB.

Let $PA = a$, $QB = b$, $AB = d$, $AE = x$. Then $EB = d-x$.

The sum is $s = \sqrt{a^2+x^2} + \sqrt{b^2+d^2-2dx+x^2}$.

$$(1) \qquad \frac{ds}{dx} = \frac{x}{\sqrt{a^2+x^2}} + \frac{x-d}{\sqrt{b^2+d^2-2dx+x^2}} = 0 \text{ when}$$

$x^2(b^2+d^2-2dx+x^2) = (a^2+x^2)(x^2-2dx+d^2)$; that is,

$b^2x^2 = a^2x^2-2a^2dx+a^2d^2$.

$$\text{Hence, } x = \frac{-2a^2d \pm \sqrt{4a^4d^2+4a^2d^2(b^2-a^2)}}{2(b^2-a^2)} = \frac{ad}{b+a} \text{ or } -\frac{ad}{b-a}.$$

The second makes PE a continuation of QP, so that $s = PE+EP+PQ = PQ$ (algebraically). The first gives both a'gebraically and geometrically a minimum value of s.

$$x = \frac{ad}{b+a}$$

satisfies (1) for unlike signs of the indicated roots;

$$x = -\frac{ad}{b-a}$$

for like signs.

II. *Solution by A. L. McCarty, Cape Girardeau, Mo., and Effie Morse, Santa Monica, Cal.*

Given plane MN and points A and B on same side of MN.

Drop AO from A ⊥ to MN and extend it to C, making OC = AO. Connect C with B. Where CB intersects MN is the required point.

Let D be any other point in MN. Draw AD, DC, DB and AP.

Now AD = DC and AP = PC.

$$\therefore \quad PC+PB = AP+PB,$$

and

$$DC+DB = AD+DB.$$

But

$$DC+DB > PC+PB.$$

Substituting, AD+DB>AP+BP.

Hence AB+PB is less than the sum of the distances from A and B to any point in MN.

343. *Proposed by R. L. Clayton, Weatherford, Oklahoma.*

Given any triangle, ABC, and a point, P, without the triangle. To draw a line through the given point so that it shall bisect the triangle. Prove by elementary geometry.

I. *Solution by I. L. Winckler, E. Cleveland, Ohio.*

Let ABC be the given triangle and P the given point. Draw a line through P parallel to one side of the triangle, say to BC, and cutting AB at R. Construct the parallelogram RLKB equivalent to one-half triangle ABC (LK being parallel to RB and K in BC). Suppose PG to be the line bisecting ABC, G being in BC. Let PG cut RB at H and LK at M.

Triangles PHR, PML and KMG are similar.

$$\therefore \frac{PML}{KMG} = \frac{\overline{PL}^2}{\overline{KG}^2}, \quad \frac{PHR}{KMG} = \frac{\overline{PR}^2}{\overline{KG}^2}$$

$$\therefore \frac{PML-PHR}{KMG} = \frac{\overline{PL}^2-\overline{PR}^2}{\overline{KG}^2}$$

But since PML−PHR = HRLM, must equal KMG, $\overline{PL}^2-\overline{PR}^2 = \overline{KG}^2$.

∴ KG may be found and PG drawn to bisect ABC.

II. *Solution by Nelson L. Roray, Metuchen, N. J.*

Let ABC be the given triangle, and let P, the given point, lie within the angle ABC. Also let h be the altitude of the triangle upon the side a, p the perpendicular from P to side b, and r perpendicular from P to side a. Suppose the straight cuts off on the side CA the sect x and on the side CB the sect y.

Then we have the following:

$$xy = \frac{ab}{2}$$

$$xy-px = \frac{ha}{2}$$

$$\therefore x = \sqrt{\left(\frac{ha}{4p}\right)^2 + a\cdot\frac{br}{2p}} - \frac{ha}{4p}$$

The expression $\sqrt{\left(\frac{ha}{4p}\right)^2 + a\cdot\frac{br}{2p}}$

is evidently the hypotenuse of a right triangle whose legs are the fourth proportional to h, a and $4p$, and the mean proportional between a and

$br/2p$. Hence x is shown to be the difference of two sects and the problem is solved by constructing the required sects and laying off their difference upon the side CA.

Trigonometry.

344. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Solve the equation:

$$\sin^{-1}\frac{2a}{1+a^2}+\tan^{-1}\frac{2x}{1-x^2}=\cos^{-1}\frac{1-b^2}{1+b^2}$$

(From Hall & Knight's Elementary Trigonometry.)

I. *Solution by R. M. Mathews, Riverside, Cal., and Emily G. Palmer, Salem, Oregon.*

$$\text{Put } A=\sin^{-1}\frac{2a}{1+a^2},\ B=\cos^{-1}\frac{1-b^2}{1+b^2},\ X=\tan^{-1}\frac{2x}{1-x^2}.$$

$$\text{Then } \tan A=\frac{2a}{1-a^2},\ \tan B=\frac{2b}{1-b^2};\text{ and since } X=B-A,$$

$$\frac{2x}{1-x^2}=\tan(B-A)=\frac{\tan B-\tan A}{1+\tan B\tan A}.$$

$$\therefore \frac{x}{1-x^2}=\frac{(ab+1)(b-a)}{(ab+1)^2-(b-a)^2}.\ \text{Let } b-a=m,\ ab+1=n.$$

$$\text{Then} \frac{x}{1-x^2}=\frac{mn}{n^2-m^2} \text{ or } mnx^2+(n^2-m^2)x-mn=0.$$

$$\therefore x=\frac{m}{n} \text{ or } -\frac{n}{m}.\ \text{Finally } x=\frac{b-a}{ab+1} \text{ or } \frac{ab+1}{a-b}.$$

II. *Solution by A. M. Harding, Fayetteville, Ark.; and H. C. Whitaker, Philadelphia, Pa.*

The equation may be written

$$\tan^{-1}\frac{2a}{1-a^2}+\tan^{-1}\frac{2x}{1-x^2}=\tan^{-1}\frac{2b}{1-b^2}.$$

Or $\quad 2\tan^{-1}a+2\tan^{-1}x=2\tan^{-1}b.$

Whence $\quad \tan^{-1}x=\tan^{-1}b-\tan^{-1}a.$

$$\text{or } x=\frac{b-a}{1+ab}.$$

Remarks by E. C. Hinkle, Chicago, Ill.

Solution I of Problem 332, published in the May, 1913, number of SCHOOL SCIENCE AND MATHEMATICS, contains an error. According to this solution the result should be 23.08 feet instead of 23.1+ feet. The solution is based on the following error: "The right triangle having one corner of the room as its right angle and the width of the carpet as its hypotenuse is similar to this" (the right triangle formed by the length, width and diagonal of the room). The length of the carpet is not parallel to the diagonal of the room. It would be if the room were square.

CREDIT FOR SOLUTIONS.

334, 335. A. M. Harding. (2)

336. Mabel Penney. (1)

339. A. Babbitt, T. M. Blakslee (2 solutions), A. M. Harding, W. W. Johnson, R. M. Mathews, Nelson L. Roray, Herbert C. Whitaker, I. L. Winckler. (9)

340. Walter C. Eells, R. M. Mathews, W. J. Risley, Harry Roeser, Nelson L. Roray, M. J. Schucker, Elmer Schuyler, F. Eugene Seymour, Levi S. Shively, I. L. Winckler. (10)

341. T. M. Blakslee, Harry Roeser, Nelson L. Roray, M. J. Schucker, Elmer Schuyler, F. Eugene Seymour, H. C. Whitaker, I. L. Winckler. (8)

342. T. M. Blakslee, Wm. B. Borgers, A. M. Harding, A. L. McCarty, H. C. McMillin, Effie Morse, Harry Roeser, Nelson L. Roray, M. J. Schucker, F. Eugene Seymour, H. C. Whitaker. (11)

343. Nelson L. Roray, M. J. Schucker, I. L. Winckler. (3)

344. T. M. Blakslee (2 solutions), Wm. B. Borgers, Walter C. Eells, A. M. Harding, R. M. Mathews, Leo Moody, Emily G. Palmer, D. H. Richert, W. J. Risley, Harry Roeser, Nelson L. Roray, M. G. Schucker, F. Eugene Seymour, H. C. Whitaker, I. L. Winckler. (16)

Total number of solutions, 60.

PROBLEMS FOR SOLUTION.

Algebra.

356. *Proposed by Robert C. Colwell, Beaver Falls, Pa.*

Show that the sum of two rational integral cubes can not be equal to a third rational integral cube.

357. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Solve:

$$x^2-2xy+y^2+2x+2y-3 = 0,$$
$$y(x-y+1)+x(x-y-1) = 0.$$

Geometry.

358. *Sequel to Problem 349.*

The difference of the areas of the triangles formed by joining the centers of the circles described about the equilateral triangles constructed—(1) outwards; (2) inwards—on the sides of any triangle, is equal to the area of that triangle.

359. *Proposed by H. E. Trefethen, Waterville, Maine.*

Prove that the angle-bisector in any triangle is less than the arithmetic mean of the two adjacent sides.

Trigonometry.

360. *Proposed by Nelson L. Roray, Metuchen, N. J.*

If θ be the angle between the diagonals of a parallelogram whose sides a, b are inclined at an angle α to each other, show that

$$\tan\theta = \frac{2ab \sin\alpha}{a^2-b^2}.$$

EPSOM SALTS.

Word was lately received from one of the research chemists of the General Chemical Company, of New York City, that they were trying to find a method for producing Epsom Salts from Dolomite rock. It is interesting here to note that during the year 1910-11 three such methods were developed in the Cornell Chemical Laboratory, and published in the May, 1911, number of SCHOOL SCIENCE AND MATHEMATICS. One hundred pounds of the rock will yield sixty pounds of Epsom Salts. It is not only used as a medicine, but has a wide application in the arts. The rock in Mount Vernon, and throughout northeastern Iowa is Dolomite; and there may some day be Epsom Salt factories in our midst.

SCIENCE QUESTIONS.

BY FRANKLIN T. JONES,
University School, Cleveland, Ohio.

Readers of SCHOOL SCIENCE AND MATHEMATICS *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Harry B. Davis, 902½ Portage Ave., South Bend, Ind., wishes to know if the following mathematical tables are in print. Send answers direct to Mr. Davis.

G Vega-Tabulae Logarithmo-Trigonometricae or the edition by J. A. Hulsse-Sammlung mathematischer Tafeln-Leipzig.

Peter Barlow—New Mathematical Tables.

Questions and Problems for Solution.

116. *Proposed by George Yale Sosnow, Newark, N. J.*

Why does throwing the hands out of water cause the head of a swimmer to be submerged?

117. *Proposed by G. Y. Sosnow, Newark, N. J.*

The motor of an electric car can develop 200 H. P. With what velocity can the car run against a uniform resistance of 2,200 pounds?

Answer consecutively numbered questions from the following lists:

Yale University Entrance Examination.

Friday, 2:00-4:30, June, 1913.

Chemistry.

1. State briefly the meaning of the following terms: (a) filtrate, (b) precipitate, (c) sublimation, (d) ignition.

2. Write equations for the reactions between the following: (a) sodium and water, (b) calcium oxide and water, (c) ammonia and water, (d) sodium hydroxide and a solution of magnesium sulphate.

3. Describe briefly, without equations, what takes place (a) when sulphur burns in air, (b) when the product is passed with air over spongy platinum, (c) when the product of (b) is treated with water. (d) Describe the chemical test by which the final product can be recognized.

4. What do the terms "temporary hardness" and "permanent hardness" mean as applied to water? (b) Describe a method of making "soft water" from either kind of "hard water." (c) Mention the materials and sketch the apparatus used in the laboratory preparation of hydrochloric acid. (d) How can the product be most conveniently collected and how most certainly identified?

5. Show by equations what happens when (a) nitric acid acts on iron, (b) strong sulphuric acid acts on a mixture of manganese dioxide and potassium iodide, (c) barium chloride solution acts upon aluminum sulphate, (d) a solution of sodium hydroxide acts upon arsenious oxide.

6. How many liters of hydrogen and how many liters of nitrogen will be produced by the decomposition of 10 liters of ammonia? (All gases measured at 0° C. and 760mm.)

7. What volume would the ten liters of ammonia occupy if the conditions changed to 15° C. and 740mm. pressure?

118. How many cubic centimeters of a hydrochloric acid solution (density 1.1 and containing 20 per cent pure acid by weight) are required to neutralize 100 grams of sodium hydroxide?

(Atomic weights: $H = 1$, $N = 14$, $Cl = 35.5$, $O = 16$, $Na = 23$.)

Physics.

1. Define the terms force, power, velocity, acceleration. Name and explain the unit in which each of these quantities is measured.

119. State the principle of Archimedes. A block of ice having a density of 0.917 grams per c.c. is floating on water which has a density of 1.03 grams per c.c. What portion of the block will be immersed and what portion will be exposed?

3. What do you understand by the coefficient of expansion of a gas? How do the coefficients of different gases compare? What experimental facts suggest the idea of an absolute zero? Describe the physical significance of such a temperature.

4. Compare light and sound waves as to mode of vibration, and as to velocity.

5. Compare a Daniell cell and a storage cell. In what respects is one superior to the other?

6. Explain the operation of the induction coil or transformer.

7. A coil having a resistance of 20 ohms is shunted with a coil of 25 ohms; what is the resistance of this divided circuit?

8. Represent by a diagram a diverging lens and show how it modifies light passing through it. Explain. Show by a geometric construction how such a lens forms an image. Point out any application which is made of such a lens.

County Examination Questions; Kansas, June, 1913.
Elementary Science, Physics.

1. What are the three forms of matter?
2. Explain the use of the lever and describe its three forms.
3. Describe an experiment to illustrate capillary attraction.
4. Upon what principle is the thermometer constructed?
5. Describe an experiment to show that sound is produced by vibrations.
6. What is the effect when rays of light pass through a prism?
7. What is static electricity? Describe a simple experiment by which it may be produced.

Answers and Solutions.

106. *Proposed by E. Carl Watson, Brazil, Ind.*

400 gm. of mercury are heated to a temperature of 71 degrees C. and dropped into 200 gm. of water at 20 degrees C. In the copper beaker are also a 30 gm. steel ball and a 20 gm. brass ball. The temperature of the water, beaker, etc., is raised to 23 degrees C. From these data what is the specific heat of mercury?

Solution by Leonard O. Merrill, Dover, N. H.

Let h = the specific heat of mercury.

$71°—23° = 48°$, the number of degrees the mercury decreased in temperature.

$(400 \text{x} 48)h = 19{,}200h$, the number of calories of heat lost by the mercury.

$23°—20° = 3°$, the number of degrees the water, etc., increased in temperature.

Specific heats: water, 1; copper, 0.0933; steel (iron), 0.1125; brass, 0.0940.

200x1x3 =	600.	number of calories of heat gained by water.
100x.0933x3 =	27.99	number of calories of heat gained by copper.
30x.1125x3 =	10.1250	number of calories of heat gained by steel.
20x.0940x3 =	5.6400	number of calories of heat gained by brass.
	643.7550	number of calories of heat gained by all.

The number of calories of heat lost by the mercury = the number of calories of heat gained by the water, etc.

$19{,}200h = 643.755.$
$h = 0.0335$, the specific heat of mercury. Ans.

Also solved by Adrain G. Bowne, Cedar Rapids, Iowa; Enis M. Dunn. Aledo, Ill; H. E. McMillin, Lawrence, Kans; C. A. Smith, Oakland, Iowa.

107. *From Crew's General Physics.*

A clock having a pendulum 60 cm long keeps correct time. The pendulum is lengthened to 60.5 cm. How many seconds will the clock lose per day?

Solution by George Yale Sosnow, Newark, N. J.

The time of vibration of a pendulum varies directly as the square root of its length. Therefore, since the lengthened pendulum is $\frac{60.5}{60}$ as long as the shorter one, its time of vibration will be $\sqrt{\frac{60.5}{60}}$ as much as that of the first pendulum. Obviously the lengthened pendulum will make $\frac{1}{\sqrt{\frac{60.5}{60}}}$ or $\sqrt{\frac{60}{60.5}}$ times as many oscillations as the shorter one. Therefore, it will lose $\left(1-\sqrt{\frac{60}{60.5}}\right)$ of the number of seconds in 1 day.

$\sqrt{\frac{60}{60.5}} = .9982.$

$1-\sqrt{\frac{60}{60.5}} = .0018.$

The number of seconds in 1 day = 86,400.

.0018x86,400 = 155.52.

∴ the pendulum will lose about 155 seconds per day.

108. *From Crew's General Physics.*

From the basket of a balloon hangs a spring balance. This balance carries a mass of 100 grams. The balloon, ascends with an acceleration of 200 C. G. S. units. What will be the apparent weight of the 100 grams during the ascent?

Solution by the Editor.

The total acceleration during the ascent is 980+220 = 1200 C. G. S. units. The spring balance interprets an acceleration of 980 as one gram, hence it will interpret an acceleration of 1200 as 1.224 gm. and it would then read 122.4 grams as the apparent weight of 100 gm.

(One incorrect solution was received.)

110. *From a Dartmouth College Examination.*

The pitch of a screw is 2 cm. and the lever is 3 m. long. If the efficiency of the machine is 20 per cent, how much can a man lift with this screw if he exerts a pull of 50 kgm. on the end of the lever?

Solution by G. Y. Sosnow, Newark, N. J.

The mechanical advantage of the screw is

$$\frac{\overset{2}{2}\text{x}\overset{r}{300}\text{x}\overset{\pi}{3.1416}}{2(\text{pitch})} = 942.48.$$

Let x = no. of kilos he could lift if effic. were 100 per cent.

Then $\frac{x}{50} = 942.48$.

and $x = 47{,}124$.

But the efficiency is only 20 per cent.

∴He can lift 20 per cent of 47,124 kilos or 9,424.8 kilos.

CITY CONVENIENCES IN A COUNTRY SCHOOL.

How a small one-teacher school in the country may have all the conveniences popularly supposed to be the exclusive privilege of the city is demonstrated in the model rural school at Kirksville, Mo., according to H. W. Foght, specialist in rural education for the United States Bureau of Education. Indoor toilets and shower baths, drinking fountains, and a modern heating plant, are shown to be possible in the country school, however remote from the city. Furthermore, the cost is said to be within the means of a comparatively small community.

The Kirksville school is conspicuous for its utilization of every available inch of space. It is only a one-story building, slightly wider than the typical Missouri country school, but the attic and basement are both put to valuable use. The attic is employed for manual training and domestic science, and there is an excellent herbarium. The basement contains the heating plant, a combination of hot water and hot air, described as very economical in use; the fuel room; a bulb room for the outdoor garden; and a dark room for developing photographs.

The machinery of the school plant consists of an ordinary pneumatic pressure tank, operated by a gasoline engine. A septic-tank sewer system in maintained at small expense.

The main floor of the building, besides containing the classroom proper, has a small community library, separate from the school library, emphasizing the purpose of the rural school as a community center. The classroom itself occupies most of the floor. The desks and seats in it are both adjustable and movable, with individual platforms; and when all are removed to one side, as many as 200 people can be accommodated, thus making it possible to use the room for community gatherings. The stereopticon in the wall of the classroom emphasizes still further the fact that this school is built for general community use as well as for ordinary school purposes.

Every effort has been made to have the model rural school at Kirksville approximate actual rural conditions. Although located on the campus at the Kirksville Normal School, it is detached from the other buildings. The pupils are real rural material. Every morning a transportation wagon brings in 34 country children from a distance of five miles. No town children are allowed to attend because it is distinctly a rural school. An expert rural teacher is in charge and the school she conducts is an observation school. Candidates for rural-school certificates attend it at least once a day and observe her work, and after two years of training in the normal school they receive practice work in the school.

"Teachers who have gone out from experience in this model rural school are 500 per cent better teachers," says Mr. Foght, "but the best indication of the value of such a school is the way its leading features have been copied. In the country about Kirksville many similar schools have been built. They do not always copy all the details, but the attic arrangement and the sanitary equipment are generally duplicated. Buildings modeled on the Kirksville school have been erected in Mississippi and Nebraska."

ARTICLES IN CURRENT PERIODICALS.

American Botanist for May; *209 Whitley Ave., Joliet, Ill.; $1.00 per year:* "The Origin of the Plum Island Flora," Willard N. Clute; "The Bitterroot," S. I. Anthers; "The Spider Flower," Willard N. Clute.

American Forestry for May; *1410 H. Street, N. W., Washington, D. C.; $2.00 per year, 20 cents a copy:* "The Ohio Floods; Their Cause and the Remedy" (13 illustrations), Robert V. R. Reynolds; "The Return of the Beaver to the Adirondacks" (6 illustrations), E. A. Sterling; "Yellowstone National Park" (16 illustrations), Arnold Hague; for June—"The National Forests as a People's Playground" (13 illustrations), Agnes C. Laut; "Forest Fire Prevention" (13 illustrations), Warren H. Miller; "Forest Conditions of Nova Scotia" (14 illustrations), B. E. Fernow; "A Fine Forestry Exhibit" (1 illustration); "The Cedar of Lebanon" (1 illustration), George B. Nash; "An Argument for Forest Planting," Montgomery Rollins.

American Mathematical Monthly for June; *Benjamin F. Finkel, Springfield, Mo.; $2.00 per year, 25 cents a copy:* "Incentives to Mathematical Activity," H. E. Slaught; "History of the Exponential and Logarithmic Concepts," Florian Cajori; "A Simple Formula for the Angle between two Planes," E. V. Huntington; "A Direct Definition of Logarithmic Derivative," E. R. Hedrick; "Two Geometric Applications of the Method of Least Squares," J. L. Coolidge; "Computation Formula for the Probability of an Event Happening at least c times in n Trials," E. C. Molina.

American Naturalist for May; *Garrison, N. Y.; $4.00 per year, 50 cents a copy:* "Inheritance of Mammæ in Duroc Jersey Swine," Edw. N. Wentworth; "Natural and Artificial Parthenogenesis in the Genus Nicotiana," Richard Wellington; "Simplified Mendelian Formulae," R. A. Emerson; "The Influence of the Development of Agriculture in Wyoming on the Bird Fauna," B. H. Grove; "The Depths of the Ocean," Alfred G. Mayer; "The Growth of Groups in the Animal Kingdom," H. S. Jennings.

Education for May; *120 Boylston St., Boston; $3.00 per year, 35 cents a copy:* "Greater Flexibility in College Entrance Requirements:—I. The Needs of the High School," William H. Holmes, "II. The Attitude of the Colleges," Henry B. Huntington, "III. The New Harvard Plan," Harvey N. Davis; "The Eye and the Printed Page:—I. The Eye Movements in Reading," Guy Montrose Whipple, "II. The Right Way to Read," Thomas H. Briggs, "III. How Students Actually Read," Harry Lyman Koopman.

Educational Psychology for June; *Warwick and York, Baltimore, Md.; $1.50 per year, 15 cents a copy:* "The Learning of Delinquent Adolescent Girls, as Shown by a Substitution Test," Bird T. Baldwin; "Oral and Silent Reading of Fourth Grade Pupils," Rudolf Pintner; "Report of the Binet-Simon Tests Given to Four Hundred Eighty-Three Children in the Public Schools of Kansas City, Kansas," Mary L. Dougherty.

Journal of the Indian Mathematical Society for May; *Madras; The Kapolee Press, 305 Thumbu Chetty St.; RS 6 per year, one Rupee a copy:* "The Three-cusped Hypocycloid and its Spherical Analogue," M. T. Naraniengar" (Stereographic Projection), T. K. Venkataraman.

L'Enseignement Mathématique for May; *Stechert & Co., West 25th Street, New York; 15 francs per year, 3 francs per copy:* "Excentricités et mystères des nombres," G. Loria; "Sur divers procédés de factorisation," A. Aubry; "Sur quelques problèms concernant le jeu de trente et quarante," D. Mirimanoff; "Application d'une transformation de M. Brocard à la construction de certaines courbes transcendantes," E. Turrière; "Un théorème sur l'hyperbole équilatère," Ant. Pleskot.

Mathematical Gazette for May; *G. Bell & Sons, Portugal St., Kingsway, London; six no., 9 s. per year, 1 s. 6 d. per copy:* "The Power-Sum Formula and the Bernoullian Function" (continued from Vol. VI., p. 336), W. F. Sheppard; Mathematical Notes; Book Reviews.

National Geographic Magazine for June; *Washington, D. C.; $2.50 per year, 25 cents a copy:* "Fifty Common Birds of Farm and Orchard" (50 illustrations in eight colors); "Birds May Bring You More Happiness than the Wealth of the Indies" (14 illustrations), Frank M. Chap-

man; "Chinese Pigeon Whistles" (With illustrations); "The Nation's Capital" (24 illustrations), James Bryce; "Curious Scenes in Out-of-the-way Places" (13 illustrations).

Photo-Era for May; *383 Boylston St. Boston; $1.50 per year, 15 cents a copy:* "Animal-Studies," William S. Davis; "Photographs of Yesterday and Today," Pierre Loti; Landscapes with Figures," Max A. R. Bruenner; Photographing Small Articles for Catalogs," "Practicus"; "The Nigrostyle," Arthur Whiting "Sulphide-Toning a Remedy for Stains," James Thomson; "Selecting a Second-Hand Camera" (concluded), Virginia F. Clutton; "Improvements in the Bromoil-Process," Dr. Emil Meyer; "The Use of Ray-Filters," W. H. Garnberg; for July—"Marine Photography," B. F. Langland; "Selection, Care and Storage of Dryplates," David J. Cook; "The Camera as a Friend," Richard M. Pertuch; "Some Phases of Pigment-Printing," Casper W. Miller, M. D.; "A Little Talk Upon Landscape-Photography," Frederick F. Ames, Jr.; "The Point of View and Its Relation to Perspective," William S. Davis.

Physical Review for May; *Ithaca, N. Y.; $6.00 per year, 50 cents a copy:* "The Hall Effect and Some Allied Effects," Alpheus W. Smith; "The Effect of Dielectrics on Unipolar Induction," E. H. Kennard; "The Stability of Residual Magnetism," N. H. Williams; "Note on the Velocity of Electrons Liberated by Photo-electric Action," Karl T. Compton; "The Variation of the Alpha-Ray Ionization of Radioactive Solids with the Thickness of the Layer," Herbert N. McCoy; "The Periods of Transformation of Uranium and Thorium. Herbert N. McCoy; for June—"Multiple Reflection of Short Electric Waves from Screens of Metallic Resonators," W. L. Severinghaus and W. S. Nelms; "A Systematic Study of Linear and Non-Linear Resonators for Short Electric Waves," W. S. Nelms and W. L. Severinghaus; "Specific Inductive Capacity and Atomic Charges," Fernando Sanford; "A Study of the Reversible Pendulum. Part III. A Critique of Captain Kater's Paper of 1818," John C. Shedd and James A. Birchby; "On a Method of Comparing Inductance and Capacity," W. E. Forsythe.

Popular Astronomy for June-July; *Northfield, Minn.; $3.00 per year, 15 cents a copy:* "The Observatory of the Astronomical Society of France" Plate XXI; "Is Radium in the Sun?" S. A. Mitchell; "Three Hundred years of Research on the Motions of the Satellites" (Concluded), Kurt Laves; "An Observatory for Variable Star Work," S. C. Hunter; "Three Centuries of Total Eclipses of the Sun in Mexico," David Todd.

Popular Science Monthly for June; *Garrison, N. Y.; $3.00 per year, 30 cents a copy:* "Some Further Applications of the Method of Positive Rays," J. J. Thomson; "The Abalones of California," Charles L. Edwards; "The American College as it Looks from the Inside," Charles H. Handschin; "Alcohol from a Scientific Point of View," J. Frank Daniels; "The Biological Status and Social Worth of the Mulatto," H. E. Jordan; "The Evidence of Inorganic Evolution," Sidney Liebovitz; "A Statistical Study of Eminent Women," Cora Sutton Castle; for July—"Ancient Man, His Environment and His Art," George Grant MacCurdy; "Suspended Changes in Nature," James H. Walton; "Heredity, Culpability, Praiseworthiness, Punishment and Reward," Dr. C. B. Davenport; "Gustav Theodor Fechner," Frank Angell; "The Intellectual and the Physical Life," Dr. James Frederick Rogers; "Women Teachers and Equal Pay," Mrs. Elfrieda Hochbaum Pope; "The Business Man and the High School Graduate," James P. Munroe; "Vulgar Specifics and Therapeutic Superstitions," Dr. Max Kahn.

Psychological Clinic for May; *College Hall Philadelphia, Pa.; $1.50 per year, 20 cents a copy:* "Curriculum Making," William E. Grady, principal Public School 64, Manhattan, New York City; "Progress of Repeaters of the Class of 1912 of the Public Schools of Washington, D. C.," Katherine H. Bevard, Principal Ross School, Washington, D. C.; for June—"Reaverments Respecting Psycho-Clinical Norms and Scales of Development," J. E. Wallace Wallin, Ph.D., Professor of Clinical Psychology, School of Education, University of Pittsburg, Pa.; "Some Reconstructive Movements

Within the Kindergarten," Luella A. Palmer, Assistant Director of Kindergartens, New York City.

Scientific American for July 5; *361 Broadway, New York; $3.00 per year, 10 cents a copy:* "The Beehive and By-Product Oven in Cake Production"; "Some Novel Uses of Compressed Air"; "Fuel Production in the United States"; "Ozone as an Aid to Good Health"; "The Geneology of the Motorcycle," J. J. O'Connor.

Scientific American Supplement for July 5; *361 Broadway, New York; $5.00 per year, 10 cents a copy:* "The Origin of Worlds" I (13 illustrations), Prof. Kristian Birkeland; "Life Hazards in Crowded Buildings Due to Inadequate Exits" (5 illustrations), H. F. J. Porter; "A French Diesel Engine" (4 illustrations); "The Spectroscope in Organic Chemistry" (4 illustrations); "Pneumatic Tires," P. W. Litchfield; "The Human Machine—How it Works"; "The Undulator" (22 illustrations), A. S. Rogers.

School Review for May; *University of Chicago Press; $1.50 per year, 20 cents a copy:* "The Practical Results of Recent Studies in Educational Statistics," Walter F. Dearborn; "The Practical Results of Recent Studies in Educational Psychology," Stephen S. Colvin; "Improvement in Educational Practice," Ernest C. Moore; "The Problem of Waste in the College Lecture," Charles F. Richardson.

School World for July; *Macmillan and Company, London, England; 7 s. 6 d. per year, 6 pence a copy:* "The Kinematograph and Geography," J. Fangrieve; "Quantitative Geography," B. C. Wallis.

Unterrichtsblätter für Mathematik und Naturwissenschaften Nr. 3; *Otto Salle, Berlin, W. 57, Germany; 4 M. per year, 60 Pf. a copy:* "Das Gleichgewicht von Drache und Motorflugzeug und die Flugzeugberechnung," Prof. Leman; "Eine anschauliche Ableitung der Summenformeln der arithmetischen und geometrischen Reihe," Dr. Ph. Lötzbeyer; "Ein neuer Hauptsatz der Trigonometrie," Ernö von Szücs; "Ueber den Ort des sogenannten 'virtuellen' Bildes," Walther Rottsieper; "Ueber die Gleichung vom vierten Grad," Karl Kommerell; "Ein Beweis des Satzes über die Seite des regelmässigen Zehneckes," Dr. R. v. Förster.

Zeitschrift für den Physikalischen und Chemischen Unterricht for May; *Prof. Dr. F. Paske, Berlin-Dahlem; Friedbergstrasse 5; 6 numbers, $2.88; M. 12 per year:* "Die Behandlung der Lichtbeugung bie Schülerübungen in gleicher Front," E. Maey; "Einführung in den Begriff der Ultramikroskopie," E. Maey; "Übungen im Bestimmen des scheinbaren Sonnendurchmessers," P. Kiesling; "Bestimmung der Schwerebeschleunigung *g* durch den direkten freien Fall," E. Zerbst; "Chemische Versuche mit Metallwolle," O. Ohmann; "Zur Demonstration der Brownschen Bewegung," H. Sehimank; "Die Wetterkartentafel ein neues Lehrmittel für den wetterkundlichen Unterricht," Lauwartz; Neue elektromagnetische Auslösung für die Gewichte der Fallmaschine," P. Anderhalden; Zur Technik des Quinckeschen Interferenzversuches," H. Riegger, J. Zenneck; "Demonstrations-Magnet nadeln," W. Merkelbach; Über die Vorgänge in der umgekehrten Ammoniakflamme," Friedrich C. G. Miller; "O. Ohmann, Über Unfälle bei den Versuchen mit flüssiger Luft.—R. Danneberg, Ein sicherer Schieber für die Wheatstonesche Brücke.—Ph. Friedrich, Zur Lenzschen Regel; Zur Ampèreschen Regel.—K. Wörner, Die Auflösung der Edelmetalle im Königswasser," Für die Praxis.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht for April; *B. G. Teubner, Leipzig; 12 numbers, 12 Mark:* "Graphische Darstellung realer und komplexer Lösungen von Gleichungen," Prof. Chr. Lenhardt; "Koaxiale Kegelschnitte am Dreieck," H. Pfaff; "Elementare Begründung des Reflexionsgesetzes," Prof. Kiesling; "Ueber eine Verallgemeinerung des pythagoreischen Lehrsatzes," Dr. Aloys Müller; "Mathematsche Lehrmittelsammlungen, inbesondere für höhere Schulen," H. Dressler; "Zur Geometrographie," edited by K. Hagge; for May—"Ueber die Methode des rein geometrischen Beweises, d. h. über die Möglichkeit zur anschaulichen Evidenz geometrischer Beziehungen zu gelangen," M. Luserke; "Zum Unterricht in der Planimetrie," Alexander Witting; "Ueber Maxima und Minima bei Pyramiden und Prismen," Rudolf Sturm; "Ueber das Maximum einer Entferningssumme," Rudolf Sturm; "Die Betonung funktioneller Beziehungen in der Reihenlehre," H. Dressler.

MOTION PICTURES IN SCHOOLS.[1]

CALIFORNIA.

Santa Barbara. In Catholic schools.
San Francisco. In Evening School for Foreigners.

COLORADO.

School for Deaf, to teach mining and farming.

A moving picture machine has been installed in the Centennial High School auditorium at Pueblo. Once a week, if possible, or at least once in two weeks, a free exhibition of moving pictures on scientific, literary, and other educational topics is given. The only regulation respecting attendance is that children must come in the care of older persons.

CONNECTICUT.

Sheffield Scientific School. Exhibition of "The Story of Pig Iron" was so successful that authorities of school are negotiating with other firms in scientific lines.

INDIANA.

Lake County has moving-picture machine for geographical study.

Gary. Superintendent Wirt is preparing a curriculum by motion pictures.

ILLINOIS.

Chicago. In Audubon School.
Decatur. School has bought its own machine.

KENTUCKY.

Paducah High School. History department has purchased a machine and finds it very useful.

KANSAS.

Kansas University Extension Department has series of lessons in morals for use of Kansas public schools.

The school authorities at Parsons have a contract with the manager of one of the theaters by which, for $25 a month, he furnishes the theater, the films, the machine, and the operator for two Friday afternoons in each month. The films are selected by the superintendent.

MASSACHUSETTS.

Fitchburg. Motion pictures used to teach morals.

MARYLAND.

Annapolis Naval Academy has been using motion pictures for nearly a year.

MINNESOTA.

University of Minnesota has purchased a motion-picture camera for the use of Prof. D. D. Mayne. Most pictures will be on subject of domestic science. Moving-picture machines have been established in many of the schools in St. Paul.

Minneapolis. Motion pictures have been introduced into the schools to teach geography and history.

MISSOURI.

Used by University School of Engineering at Columbia to demonstrate engineering processes, for example, to show evolution of iron ore into finished steel product, and to show such works as Panama Canal.

[1]We are indebted to Miss Sara L. Levier, Educational Secretary, National Board of Censorship of Motion Pictures, New York City, for this article.

NEW JERSEY.

Newark High School. Geography.

Orange. Motion-picture equipment has been established in every school building.

NEW YORK.

Rensselaer. St. Johns Academy has a motion-picture machine. Finds it of use in teaching almost any subject.

West Point. Has been using motion pictures for more than a year.

OREGON.

Monmouth State Normal School uses motion pictures to supplement class-room work. Machine is fitted for slides or motion pictures and the slides are owned by the school. Three departments are now prepared to use this machine—agriculture, science and English.

RHODE ISLAND.

Cranston. Highland Park School uses motion pictures for geography and history.

VIRGINIA.

Driver High School uses motion pictures for geography and history.

WISCONSIN.

Beloit College has an arrangement with motion-picture house whereby students see pictures several times a month in connection with lectures by the Dean, George A. Collier.

Madison. Extension division of the Wisconsin University desires to establish a State exchange of educational films, making them available at cost price to local school authorities, etc. An appropriation of $10,000 is asked this year for the purpose.

Racine. Many schools in Racine are equipped with either motion pictures or stereopticon machine which is used in studies of geography and civics.

AN EXPERIMENT FOR SHOWING LINES OF FORCE IN AN ELECTROSTATIC FIELD.

Everyone is familiar with the method of mapping a magnetic field of force by the aid of iron filings, which may, if desired, be made permanent by receiving the filings upon a suitable adhesive support, such as wax softened by heat.

More difficulty is experienced in mapping an electric field of force, but the following method, described by B. M. Neville in *Nature*, provides a simple means for the purpose.

The method consists simply in allowing a scrap of cotton-wool to fall between the knobs of a Wimshurst machine, or among any conductors connected with them. As soon as the bit of fluff touches on eof the conductors it moves off rapidly along a line of force. If the other conductor is oppositely charged the fluff will strike it, and again be repelled, usually in a slightly different direction, thus traversing a different line of force, and so on.

The scrap of charged fluff moves so rapidly under the electric forces that, owing to the persistence of vision, the shape of its path is very evident, and, owing to its lightness and the relatively great resistance offered by the air to its motion, its path approximates very closely indeed to the line of force.—*Scientific American Supplement.*

MATHEMATICAL AND PHYSICAL SECTION OF THE ONTARIO EDUCATIONAL ASSOCIATION.

The mathematical and Physical Section of the O. E. A. held its annual meeting in Toronto on March 25th and 26th.

The following program was carried out:

1. "The Old and the New in Arithmetic," J. T. Crawford, M. A. University School, Toronto.
2. "The Language of Mathematics," Prof. J. Matheson, Queen's University, Kingston.
3. "Geometry in the Lower School," C. L. Crassweller, B. A., Collegiate Institute, Windsor.
4. "Mathematics for Teachers," W. L. Sprung, B. A., Collegiate Institute, Stratford.
5. "Certain Leads and Certain Tendencies in Mathematical Education," Prof. A. T. De Lury, University of Toronto.
6. Election of Officers: Hon. President, Prof. A. T. De Lury; President, T. A. Kirkconnell; Vice-President, A. M. Overholt; Secretary-Treasurer, W. J. Longheed; Councillors, W. L. Sprung, G. H. Armstrong, R. Gourlay, T. Kennedy and W. R. Bocking.
7. An exhibit of some mathematical apparatus and devices, and also of some recent books dealing with elementary and secondary mathematics.

H. S. R.

SOUTHERN CALIFORNIA SCIENCE AND MATHEMATICS ASSOCIATION.

The spring meeting of the Southern California Science and Mathematics Association was held at Pomona College, Claremont, Saturday, April 12, 1913.

At the morning session the following program was presented:

Music—Pomona College Glee Club.

Address of Welcome—President James A. Blaisdell, Pomona College.

Address, "Cement"—W. C. Hanna, Chemist California Portland Cement Co., Colton, Cal.

Address, "The Psychology of Suggestion"—Dr. R. D. Williams, Pomona College.

At the business meeting following these addresses, the president was authorized to appoint a committee to consider the advisability of publishing a bulletin of proceedings. This Committee was given power to act.

After luncheon, which was served at the College Inn, a half hour was spent in inspection of the college laboratories and observatory and the Claremont High School building.

The afternoon was given over to meetings of the Science and Mathematics Sections.

Mathematics Section.

"Mathematical Translation of English"—Theodore Fulton, Manual Arts High School, Los Angeles.

"High School Mathematics Here and There"—A. F. Vandergrift, Polytechnic High School, Los Angeles.

Science Section.

"Variations in Productiveness of Citrus Trees"—Carl S. Milliken, Citrus Experiment Station, University of California.

"The Human Face"—Professor W. A. Hilton, Pomona College.

"The Breeding Habits of Some California Birds"—Chas S. Thompson, South Pasadena High School.

The meetings were well attended and the addresses measured up to the high standard which has been set at previous meetings. Pomona College proved a good host. The reception committee emphasized the welcome extended by President Blaisdell at the morning session.

The Science section of the Association was organized about four years ago, and soon joined with the Mathematics Association, which had been in existence for some time, to form the larger association. The following sections have been organized: Mathematics, Biology, Earth Science, Physics-Chemistry.

The general association holds two meetings during the year, and in addition to these the different sections hold special meetings as they desire.

An amendment was recently adopted adding all past presidents to the executive committee. FRANK G. REID.

AMERICAN FEDERATION.

The Council of the American Federation of Teachers of the Mathematical and Natural Science held its seventh annual meeting at Adelbert College, Cleveland, Ohio, on December 31, 1912.

The roll call showed the following members present either in person or by proxy:

John H. Woodhull, Teachers' College, New York.
Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.
C. R. Mann, University of Chicago, Chicago, Ill.
Guy W. Smith, Boulder, Colorado.
J. A. Randall, Pratt Institute, Brooklyn, N. Y.
G. R. Twiss, Ohio State University, Columbus, Ohio.
H. T. Clifton, 509 E. Walnut St., Pasadena, Cal.
Wm. H. Metzler, Syracuse University, Syracuse, N. Y.

The minutes of the previous meeting held at the New Willard in Washington, D. C., were read and approved. The treasurer, Mr. Eugene R. Smith, of the Park School, Baltimore, Md., sent the following report:

Receipts.

Balance from 1911		$ 67.78
Dues for 1911:		
New England Mathematical Society	$18.40	18.40
Dues for 1912:		
Missouri Society of Teachers of Mathematics and Science	$ 8.10	
Central Assn. of Science and Mathematics Teachers	48.60	
Physics Teachers Association of Washington, D. C.	2.50	59.20
Total		$145.38

Expenditures.

Postal card notice of 1911 meeting	$ 1.85
Committee on Physics	50.00
Postage	1.76
Balance on hand December 31, 1912	91.77
	$145.38

Reports for the year were presented by the following associations:
Central Association of Science and Mathematics Teachers.

Colorado Mathematics Association.
Middle States and Maryland Mathematical Association.
New England Mathematical Association.
New York State Science Teachers' Association.
Ohio Teachers of Mathematics.
Physics Club of New York.
Physics Teachers Association of Washington, D. C.
Southern California Science and Mathematics Association.

The following officers were elected for the next year:

President—C. R. Mann, University of Chicago.

Secretary and Treasurer—Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.

After much discussion on the financing of its affairs the following resolution was adopted:

Pending an investigation as to the possible means of financing the work of the Federation the council resolves that the associations which have not done so be asked to pay up the dues for 1912 but that the dues for the year 1913 be remitted.

The present members of the Council are as follows:

Charles A. Hobbs, Watertown, Mass.
William H. Metzler, Syracuse University, Syracuse, N. Y.
J. S. Stokes, State Normal School, Kirksville, Missouri.
John H. Woodhull, Teachers' College, N. Y.
William A. Hedrick, McKinley Manual Training School, Washington, D. C.
C. R. Mann, University of Chicago, Chicago, Ill.
George R. Twiss, Ohio State University, Columbus, Ohio.
Guy W. Smith, Boulder, Colorado.
J. A. Randall, Pratt Institute, Brooklyn, New York.
F. E. Goodell, North High School, Des Moines, Iowa.
H. T. Clifton, 509 E. Walnut St., Pasadena, California.

The treasurer was authorized to pay Seventy (70) Dollars to Mr. W. H. Metzler, of Syracuse, N. Y., to help in paying for the work done by the National Committee on Geometry; to pay Fifty (50) Dollars to Mr. J. A. Randall, of Brooklyn, N. Y., to help in paying for expenses incurred in making and distributing blue prints of designs and apparatus for school construction and models of commercial articles for use in the laboratory.

The reports from the affiliated societies spoke very emphatically of the necessity of an improvement in the laboratory apparatus because of the erratic behavior of much of that which is now on the market. Makers should always send explicit directions for adjustment of apparatus. We teach the pupils to have no respect for any experimental work. Approved apparatus and methods unique in any school are greatly desired. Some reports suggested that the joint committee on science teaching should make a careful study of the social value of the science as applied to the individual student in his environment. The habit of turning over classes in mathematics to teachers of languages was condemned. All reports agree that the present is not the proper time to define the scope of the unit in physics but that suggestions and contributions should be obtained from all teachers of physics in order that a more sane course may make a unit practicable. Data, on Panama Canal, from the big mining and transportation companies, should be obtained to formulate present day problems. Meetings are still held by the many affiliated societies, some have preferred home talent, others selecting their speakers from the men who are doing things outside of the school room.

WM. A. HEDRICK, Secretary.

PERSONALS.

J. M. Jameison, for seventeen years head of the physics department of Pratt Institute, Brooklyn, has been made vice-president and executive head of Girard College. He will have full charge of educational and vocational work in the college.

Professor W. O. Fiske, head of the geology department of Occidental College, Los Angeles, has resigned to accept the position of Director of the Chaffey Library Foundation, Ontario, California. This institution was founded in the interest of scientific investigations.

Dr. H. E. Slaught, of the mathematics department of the Chicago University, has been promoted, to a well deserved, full professorship in that institution.

Mr. R. O. Barton, graduate student in the University of Chicago, has been appointed instructor of mathematics in the University of New Mexico, at Albuquerque.

Mr. Leonard P. Dove, from the University of Chicago, receives the appointment of instructor in physics and chemistry in the high school at Lead, South Dakota.

Miss Nina Streeter, from the School of Education, Chicago, goes to Westport high school, Kansas City, Mo., as instructor in household arts.

Harold R. Kingston goes from the University of Chicago to the University of Manitoba, Winnipeg, Canada, as instructor in mathematics.

Dr. Ralph E. Root, has been appointed from the University of Chicago, to the United States Naval Academy, Annapolis, as instructor in mathematics.

Miss Jean MacKinnon of the University of Chicago has been appointed to an instructorship in household chemistry at Iowa State College, Ames.

Miss Bertha Riley of the University of Chicago accepts the position of instructor in household art at Iowa State College, Ames.

Miss Margaret Belyea from the university of Chicago has been made instructor in botany and chemistry in the high school, Beloit, Wisconsin.

Miss Mary R. Payne, graduate department of the University of Chicago, goes to Oak Park, Ill., high school as instructor in mathematics.

Drs. Veranus A. Moore, director of the New York State Veterinary College; W. T. Sedgwick of the Massachusetts Institute of Technology and J. A. Carway of the Missouri Agricultural College have been selected by the Secretary of Agriculture from outside of the Government service to make an inspection of the meat packing establishments of the country. Better men could not have been chosen. Their report will be valuable and interesting.

Dr. Frank D. Kern, associate in botany to the Indiana Agricultural Experiment Station, has been made professor of botany in the Pennsylvania State College.

Dr. P. G. Stiles, assistant professor of Physiology at Simmons College, has been made instructor of physiology at Harvard University.

Dr. George E. Fellows, formerly president of the University of Maine, succeeds Dr. Albert R. Taylor as president of James Millikin University, Decatur, Illinois.

Dr. J. Frank Corbett, state bacteriologist of Minnesota, has resigned to devote his entire time to his work in the department of experimental surgery in the University of Minnesota School of Medicine.

Dr. John H. Finley, president of the College of the City of New York for ten years past, has been elected State Commissioner of Education of New York by the State Board of Regents. His term of office is indefinite. He succeeds the late Andrew S. Draper. Dr. Finley is a graduate of

Knox College, class of 1887. He was a graduate student in history and economics at Johns Hopkins University, and then became secretary of the State Charities Aid Association of New York. From 1892 till 1899 he was president of Knox College. He resigned to undertake editorial work for *Harper's Weekly* and *McClure's Magazine*. Shortly afterward he succeeded to Woodrow Wilson's Professorship of politics at Princeton. He was at Princeton for three years and then, in 1903, he accepted the presidency of the College of the City of New York.

Mr. James S. Mikesh of the University of Minnesota has secured a leave of absence for one year in order to do graduate work in mathematics at Harvard University.

Professor Francis C. Lincoln, professor of mining engineering in the University of Illinois, has resigned to accept the position of engineer for the Bolivian Development Company of La Paz, Bolivia.

President F. P. Venable of the University of North Carolina has been granted a leave of absence for one year. Dean E. K. Graham will act in his stead.

Professor Willy Wien, professor of physics in the University of Wüizburg, delivered a course of six lectures at Columbia University, on "Recent Problems of Theoretical Physics."

The Smithsonian Institution will include in its "Annual Report of the Board of Regents to Congress," the paper by Associate editor Professor G. A. Miller of this Journal entitled "Some Thoughts on Modern Mathematical Research."

Northwestern University at its recent commencement conferred upon Professor Robert A. Millikan of the University of Chicago, in recognition of his recent discoveries in electricity, the degree of doctor of science.

Messrs W. O. Beal and W. L. Miser, who received distinction at the University of Chicago last June have been appointed instructors in mathematics at the University of Minnesota.

Mr. C. R. Dines, graduate student from the University of Chicago, has been made instructor in mathematics at Northwestern University.

Professor Saul Epsteen, professor of engineering mathematics at the University of Colorado and associate editor in Mathematics of this Journal has been granted leave of absence. He spends this year at Denver as state commissioner of insurance.

Mr. G. W. Smith, of the University of Colorado, has been appointed assistant in mathematics at the University of Illinois.

Mr. G. W. Hen, of the University of Michigan, has been appointed of the department in mathematics in Shurtleff College, Alton, Illinois.

Mr. D. M. Smith and Mr. D. L. Stamy, graduate students at the University of Chicago have been appointed instructors in mathematics in the Georgia School of Technology, Atlanta.

Miss Mildred L. Sanderson, from the University of Chicago has been made an instructor at the University of Wisconsin.

Mr. J. A. Randall, for many years instructor in physics in Pratt Institute, has been made head of the department.

MUCH PUMICE USED.

The pumice produced in the United States last year amounted to 27,146 short tons, valued at $86,687, according to the United States Geological Survey. This was an increase of 5,457 tons in quantity and a decrease of $1,712 in value compared with 1911. In quantity the production is the largest on record, but the average price per ton and the total value were less than those of the two preceding years.

EDUCATION NOTES AND COMMENTS.

Louisville, Ky., has established an open-air school.

Football is forbidden in the schools of Bavaria by a recent decree.

German universities enrolled 64,590 students during the year 1912-13.

Nearly two-thirds of the American public school enrollment is in the rural schools.

Berlin is to have compulsory industrial and commercial continuation school for girls.

The largest public school building in Europe is the new continuation school in Vienna.

Home economics is to be made compulsory in the primary schools of Saxe-Weimar, Germany.

South Haven, Mich., opened its splendid and finely equipped new high school building this fall.

Of the 85 foreigners who are in Rome this year studying the Montessori schools, 60 are Americans.

How does that teacher expect to get work done promptly by her pupils when she is herself habitually late?

Danville, Va., a city of less than 20,000 population has spent $500 in equipping playgrounds on the public-school property.

More than 90 per cent of the high schools now reporting to the United States Bureau of Education have full four-year courses.

The educational expenditure for Scotland for the past fiscal year was $18,300,000, of which $840,000 was for continuation schools.

Four thousand teachers in Massachusetts, where the pay is higher than in most states, receive salaries ranging from $5.77 to $10 a week.

Students of the New York State Library School are compelled to spend one month in practice work in any library they select in the United States.

Of France's 227,000 recruits in 1912, 3.46 per cent were illiterates, and 22.5 per cent had no education beyond the mere ability to read and write.

Parent-teacher circles and the civic club in Lock Haven, Pa., are co-operating to control cigarette smoking and to censor moving picture shows.

The Chicago Board of Education has established two "naturalization schools," open four nights a week, to furnish instruction to applicants for citizenship.

Three-fourths of the teachers in Alabama are holding their first position. Only seven per cent of the teachers now employed have taught more than two years.

The Spanish-American Athenæum of Washington, D. C., is seeking to make Spanish a required subject for entrance to college, on a par with French and German.

Fourteen hundred boys and girls enrolled in the Public Industrial Art School of Philadelphia study drawing, designing, modeling, and carving for two hours every day.

Over 90 per cent of the high schools in the United States have libraries, according to figures compiled by E. D. Greenman of the United States Bureau of Education.

This year's session of the Maine legislature enacted a law prohibiting secret societies in the public schools. Another act removes January 1st from the list of holidays.

The school board of Louisville, Ky., has established an open-air school for the anaemic and sickly children whose general physical condition demands special attention.

"The greatest waste in education is not bad teaching," said a speaker at the recent meeting of school superintendents, "but teaching things the twentieth century does not need."

Compulsory school bathing is enforced in the German cities of Gotha and Heilbronn. In Gotha children who can not afford bathing suits are supplied with them by the school.

The English Government is planning to provide scholarships and other aids which will make possible a university education for every boy or girl who makes a certain standard.

Y. W. C. A. representatives in and about Augusta, Ga., are working for a public library in that city. A city of over 41,000, Augusta is not yet provided with a free public library.

A parent-teachers' association, where one-half the members are men, is the fact in Gettysburg, Pa., according to information received at the United States Bureau of Education.

The foreign interest in American physical education movements is shown by the fact that a recent German periodical devoted its leading article to "The Camp Fire Girls of America."

An investigation of the Prussian schools shows that an average of 16 per cent of the pupils evade the prescribed physical exercises by physician's certificates or other means.

Those Teachers who seem to think that their duties toward school and pupil ends at the ringing of the bell at the close of the daily session, had better seek another vocation.

One citizen of Louisiana is so impressed with the need for medical inspection in the schools that he has furnished the necessary funds for the salary of the health officer in his community.

To control cigarette smoking and to censor moving-picture shows are the two subjects of a co-operative plan formed by the Parent-Teacher Circle and the Civic Club in Lock Haven, Pa.

High-school enrollment in South Carolina has risen from 4,812 to 8,902 in the past six years, and the amount paid for salaries of high-school teachers has more than doubled in the same period.

Sweden maintains schools for Laplanders' children in the North. There are nomad schools with a five-year attendance period of 36 weeks each, and fixed schools with a winter course of 13 weeks.

Wisconsin reports a revival of interest in penmanship. "Writing need not be a lost art," says State Superintendent Cary in recording the efforts of several counties to improve penmanship instruction.

A farm of 160 acres has been deeded to the schools of Paola, Kans. Money from the farm is used to buy books, clothing, etc. ,for boys and girls who wish a high-school education but can not afford it.

The Governor of Georgia sets aside one day in the year as "Public Health Day," to be observed in every school in the state, according to information received at the United States Bureau of Education.

The "school republic" or "school city" has been introduced into the Alaskan native schools by order of the United States Commissioner of Education, for the purpose of preparing the natives for citizenship.

Bloomfield, N. J., has introduced an elective vocational course in the

eighth grade giving eight periods a week in manual training and drawing for the boys and eight periods a week in sewing and cooking for the girls.

Technical schools giving courses in architecture will have a special exhibit at the International Building Exhibition in Leipzig this summer, according to information received at the United States Bureau of Education.

At least one American state finds it desirable to publish its laws in Spanish. The new Mexico department of education issues a special Spanish edition of the school laws and of constitutional provisions relating to education.

Magdeburg, Germany, is to have a school for the special training of women and girls as shop clerks. The city of Berlin has already provided such training by means of a special course for sales girls in the new continuation school.

It is planned to transform the vacant lots in Lebanon, Pa., into flourishing gardens through the aid of schoolboys. One hundred and eighty-nine boys between the ages of 8 and 14 have declared their wish to be gardeners this year.

A special course in picture framing is given in the Amelia High School, Amelia, Va., and during the past year or two more than a thousand neatly-framed pictures have gone from the school manual training shop into the pupils' homes.

For the first time the schools of Raleigh, N. C., have compulsory attendance. As a result, 729 more children are in school this year than last, and half of them are colored. The sentiment of the community is overwhelming in favor of the law.

Little Rock, Ark., spent $20,000 on playgrounds last year. The money was raised by public subscription, through the efforts of a highly-organized playground association. The enthusiasm for playgrounds has since spread to other cities in the same region, notably Pine Bluff.

A traveling school of domestic science has been instituted in the department of Yonne, France. The school will make a stay of three months in any commune where an attendance of fifteen is guaranteed. Similar itinerant schools for domestic science exist in Ireland.

One of the sources from which the greatest number of teachers were secured to take the examination for instructorships in the Chicago city high schools, last summer, was through the notices printed in this JOURNAL in April, May and June. This speaks well for its circulation.

Rutland, Vt., has had for ten years a summer school for pupils who fail of promotion in the regular classes. Eighty per cent of the pupils have made up deficiencies and been promoted, and nearly all those promoted have continued to make good during the year that followed.

To promote moral education in the schools of France independently of religious doctrine is the object of the "French League for Moral Education." The league offers a first prize of $1,000 and other prizes amounting to $2,000 for contributions to a bulletin which it publishes.

A number of the leading business and professional men are giving talks to the high-school students at Shelbyville, Ind., on vocational topics, thereby giving the boys and girls the benefit of the experience of the men who are doing the work and solving the problems of that community.

Correspondence courses in health will be one of the features of the health instruction bureau to be established at the University of Wisconsin,

which aims to reach the people of the whole state with available information on preventable disease, infant mortality, rural hygiene, and other subjects.

Two teachers in the schools of Berlin, Germany, are this year celebrating their fiftieth anniversary of school-teaching. There are 42 others who have taught forty years, and 47 who have taught twenty-five years. The Berlin Teachers' Society will tender a banquet to these veterans in December.

Parents who keep their children at home to help in the housework and with the family washing have been warned by the Milwaukee authorities that these will not be considered valid excuses for keeping children out of school. The truant authorities have been ordered to be on the lookout for all such cases.

Cincinnati has tried compulsory vocational training and is well satisfied with the result. The boys and girls did not like it at first, apparently because of the compulsory feature, but now seem to take to it with enthusiasm. The school authorities have had the hearty co-operation of the manufacturers in the work.

What can be done to free the minds of many teachers that the main duty of the teacher is not to fill the pupils' minds with a lot of information about chemistry, mathematics, Latin, etc., but on the contrary it is to teach the pupils how to think and use their own resources, in fact how to become true men and women?

In Pittsburgh 48 per cent of the 63,141 elementary pupils investigated were behind grade, while 11 per cent were retarded three years or more. Dr. J. E. W. Wallin, director of the recently organized psychological clinic of the University of Pittsburgh, declares that at least 3,300 of the children should be in special classes.

In a recent comparison between pupils in a closed-window schoolroom and those in an open-window room in Philadelphia, it was found that the open-window class surpassed the others in almost every test. The temperature of the closed schoolroom averaged 68 degrees, while for the open-window room it was 47 degrees.

Mississippi has built 27 county agricultural high schools in the past two years at an average cost of $30,000 per school. These schools furnish board and dormitory facilities for $5.50 per month, and the boys and girls are paid a certain amount per hour for the work they do, so that in most cases the expense to the pupil is reduced to about $3 per month.

The following statement from the registrar of the Hyde Park High School of Chicago shows the trend of people to the cities, especially Chicago. He says that during the school year of 1912-1913 he admitted into that school about 250 pupils coming from nearly every state in the Union, as well as several from Europe, Japan, and the Canal Zone.

The school directors of Dubois, Pa., have under advisement a new salary schedule prepared by W. R. Straughn, superintendent of city schools, based on preparation, adequate experience to allow for maturity of teaching ideals, and on *efficiency*. Great length of service has nothing to do with the salary question. The test of efficiency is the average of the estimate of the principals and of the superintendent.

The school system of Boise City, Idaho, was recently reorganized on the basis of a careful survey of the city's needs made by a committee of educational experts. So well satisfied were the people of the city that a number of them came to Superintendent Meek and offered him 160 to 300

acres of land and half a million dollars if he would go further and develop the local high school into an industrial city college.

The board of education of Bristol, Conn., has passed a rule permitting high-school pupils to substitute music, either instrumental, vocal, or theoretical, for a high-school study. In order to do this they must do a specified amount of work under a teacher approved by the board of education and reports must be made by the music teacher and the parents in regard to progress and practice. The superintendent reports good results from this plan.

An outdoor performance of a drama of African life, "For Unkulunkulu's Sake," was a feature of the forty-fifth anniversary of Hampton Institute, recently celebrated. This four-act play presented vividly and sympathetically existing conditions of ignorance and superstition in Africa, and indicated how life in the dark continent might be improved through the introduction of the type of industrial and agricultural education for which Hampton is noted.

Fitchburg, Mass., which has had a co-operative industrial course in successful operation for the past five years, has been experimenting this year with a co-operative commercial course. Several seniors have been alternating each half day between office and school, thus learning bookkeeping and stenography under office conditions. The experiment has been so successful that more seniors will have an opportunity next year to go into offices one-half of each school day.

A commission of professional educators to judge the efficiency of school superintendents is suggested by Dr. G. D. Strayer in a current bulletin of the United States Bureau of Education. Dr. Strayer objects to the present conditions "whereby a politician, an interested book-publishing company, or a personal enemy" is permitted to attempt the removal of the superintendent without any adequate measure of his work. Dr. Strayer thinks a permanent commission of experts would change all this.

The superintendent of the Chicago schools, Mrs. Ella Flagg Young, instituted in its 21 high schools, last semester, a marching contest for a prize of $50.00 given by her to the school which showed the best all-round form. The contest was decided by five judges who witnessed the marching in each school. This undoubtedly is an excellent plan as far as getting the pupils out-of-doors is concerned, but it breaks up the continuity of school, each day preparations are made for the contest. Does it pay?

For the past ten summers the school board of Rutland, Vt., has been conducting a four-weeks continuation school for those pupils in the intermediate and grammar grades not regularly promoted. The average yearly attendance of this school has been about 60 pupils; about 80 per cent of those attending have made up deficiencies and have been regularly promoted, and about 85 per cent of those thus promoted have made good in their grades during the subsequent year. The expense to the city of maintaining the summer school has averaged about $125 per year.

The use of moving pictures in the schools is spreading rapidly in Europe. Recently a professor in a Brussels school excited great interest by presenting a series of pictures illustrating the progress of aviation from the earliest days to the present. In Prussia the minister of public instruction has approved the use of the cinematograph in all the higher schools of the country, and the official programs give lists of films for geography, history, and science. The expense of this material is met by appropriations from the government and municipalities and by private subscriptions.

THE CROCKER LAND EXPEDITION.

The Crocker Land Expedition (George Borup Memorial) sailed from the Brooklyn Navy Yard, New York, in the Newfoundland steam sealer *Diana,* on July 2, with the major portion of its equipment aboard. The ship called at Boston for 13,000 pounds of pemmican and other stores and sailed for Sydney, N. S., on July 6. Sydney was reached in the morning of the 9th, and there 40,000 pounds of dog biscuit, 13,000 feet of lumber, 40 pairs of snow shoes and 335 tons of coal were taken aboard. The *Diana* left Syndey on the 13th loaded to the rails, but she had yet to call at Battle Harbor, Labrador, to take up the 30-foot power boat *George Borup,* which has been in storage there all winter, and twenty Eskimo dogs and an interpreter. The party was to leave Battle Harbor on Thursday, July 17, headed for the west coast of Greenland. A stop may be made at Disco, West Greenland, for the purpose of setting observation stakes in the glacier there, but the first real objective point is Cape York, where the walrus and seal hunting will begin.

It is probable that much of the cargo will be landed at Payer Harbor, Pim Island, but the main headquarters of the expedition are to be established at Flagler Bay on the south side of Bache Peninsula.

The Crocker Land Expedition, which is sent out under the auspices of the American Museum of Natural History, the American Geographical Society and the University of Illinois, is probably the most thoroughly equipped scientific expedition which has been sent into the arctic regions from this country. Its scientific staff is as follows:

Donald B. MacMillan, A.B., A.M., F.R.G.S., leader and anthropologist;
W. Elmer Ekblaw, A.B., A.M., geologist and botanist;
Fitzhugh Green, U.S.N., engineer and physicist;
Maurice C. Tanquary, A.B., A.M., Ph.D., zoologist;
Harrison J. Hunt, A.B., M.M., surgeon and bacteriologist.

In addition to these there are: Jerome L. Allen, detailed by the United States Navy Department for service as wireless operator and electrician; Jonathan C. Small, mechanic and cook; while Edwin S. Brooke, Jr., is on the ship this summer as official photographer to the expedition.

It may be recalled that the objects of the Crocker Land Expedition are

1. To reach, map the coast line and explore Crocker Land, the mountainous tops of which were seen across the polar sea by Rear Admiral Peary in 1906.
2. To search for other lands in the unexplored region west and southwest of Axel Heiberg Land and north of the Parry Islands.
3. To penetrate into the interior of Greenland at its widest part, between the 77th and 78th parallels of north latitude, studying meteorological and glaciological conditions on the summit of the great ice cap.
4. To study the geology, geography, glaciology, meteorology, terrestrial magnetism, electrical phenomena, seismology, zoölogy (both vetebrate and invertebrate), botany, oceanography, ethnology and archeology throughout the extensive region which is to be traversed, all of it lying above the 77th parallel.

The installation of a powerful wireless telegraph station in connection with an arctic expedition is a new feature, by means of which, if all goes well, communication will be maintained with the party throughout their stay in the north. It is expected that daily weather reports will be sent from Flagler Bay to the Weather Bureau at Washington by way of government wireless stations in Canada which have been kindly placed by the Dominion authorities at the disposition of the expedition. News of important events in the history of the expedition and of important dis-

coveries will likewise be sent promptly to the American Museum and the public at large.

The original program of work for the expedition contemplated two years or three summer seasons in the arctic, but supplies have been taken north which will enable the party to remain three years or even longer if the results flowing from the work seem to justify the extension of time.

The mishap to the *Diana,* which went ashore at Barge Point, Labrador, since the above was written, may require the transfer of the equipment to another ship, but will not otherwise interfere with the expedition.—*Science.*

THE BEDBUG.

The alleged humor of which the bedbug, or to give him his dignified Latin name, *Cimex Lectularius,* has been the subject should not obscure the serious rôle played by the bug in common with the fly, the mosquito, the flea and the louse as a conveyor of infection. Relapsing fever, bubonic plague, kala-azar, small-pox and typhoid fever have been transmitted by various species of the bedbug, and possibly the investigator might find here the explanation of otherwise inexplicable endemics in uncleanly neighborhoods. Epidemics of smallpox have been disseminated in cheap lodging-houses by this polecat among insects; and were it not for the frequent vaccinations compelled by health departments, such epidemics would very likely be more frequent than they now are. The bedbug hides during the day and sometimes hibernates during the winter. When it lacks animal food, it feeds on the juices of decayed wood or on the dust in floor cracks, and can go without food for a long time. It may continue its existence under adverse circumstances from season to season, in lumber camps, in summer houses, empty apartments and the like.

The housewife is greatly mortified by the creature's presence under her roof; but she is by no means always blameworthy. It may get into the traveler's trunk or satchel from an uncleanly hotel or sleeping-car or invade the home in the laundry or on the clothing; thus Manning witnessed the migration of a bedbug across the aisle of a car from a sick man to the skirts of a party of women. Or it may migrate through walls from one house to another, sometimes in a continuous pilgrimage, especially when the dwellers of an infested house move away, thus cutting off the commissariat of the parasite. It may then escape through windows as well as walls, along water-pipes or gutters to new pastures. Thus the tidiest housewife may be victimized. Apart from ordinary dwellings, log cabins easily become infested; ships also entertain the bedbug in considerable degree. Poultry-houses, dove-cotes and the hiding-places of bats may easily become infested with the bedbug or nearly related species, and sparrows' and swallows' nests under eaves, which are often alive with the vermin, may be their portal of entry into houses.

A thorough extermination of the bedbug would result also in the extermination of other dangerous insects infesting houses. The local application of boiling water will kill a few bugs and drive others away, but serious efforts at extermination require fumigation. To be thorough, according to *The Journal of the American Medical Association,* this should be done systematically by the municipality. Manning has called attention to bedbug extermination as one of the measures to be employed in the prevention of all diseases whose virus is present in the blood of the patient during the acute stage of the disease. Of all methods Manning says that there is none which would exceed in effectiveness the annual compulsory fumigation of all habitations of man.

TWO NEW CHICAGO HIGH SCHOOLS.

During the spring of the present year Chicago opened two enormous high school buildings, the Hyde Park and Senn. Each of these buildings represent an investment, in round numbers of $1,000,000.00. Just now there are accommodations for 2,000 pupils in each school. It is perfectly possible, however, to take care of 3,000 students in each building at one time. The buildings are so large that it is possible for a pupil, by most direct route, in changing classes to travel almost a quarter of a mile. The buildings are constructed and equipped in such a manner that the statement made by Ezra Cornell at the founding of Cornell University, "I would found an institution where any person can find instruction in any study," can be carried out completely.

The Hyde Park High School is situated just across the street from the middle east and west line of the big and beautiful Jackson Park where the World's Columbian Exposition was held in 1893. It has an assembly hall which will seat 2,500 persons. The wood and metal working shops are all on the first floor. This building contains a swimming pool, 25x60 feet, in which the pupils, both boys and girls, will be taught how to swim. The fourth floor contains a lunch room which will accommodate 1,000 persons at one time.

Teachers visiting in Chicago should not fail to visit one or both of these schools.

BOOKS RECEIVED.

School Hygiene, by Fletcher B. Dresslar, United States Bureau of Education. Pages xi+369. 14x20 cm. Cloth. 1913. $1.25 net. The Macmillan Company, New York.

Variations in the Grades of High School Pupils, by Clarence T. Gray, University of Texas. 120 pages. 13x20 cm. Cloth. 1913. $1.25. Warwick and York, Baltimore.

Gas Analysis, by L. M. Dennis, Cornell University. Pages xvi+434. 13x19 cm. Cloth. 1913. $2.10 net. The Macmillan Company, New York.

High School Agriculture, by D. D. Mayne, University of Minnesota and K. L. Hatch, University of Wisconsin. 432 pages. 13x19 cm. Cloth. 1913. American Book Company, New York.

Academic Algebra, by Geo. Wentworth and David Eugene Smith. Pages v+442. 13x19 cm. Cloth. 1913. $1.20. Ginn and Company, Boston.

Catalogue of High School and College Text-Books. Pages xxvi+572. Cloth. 1913. Ginn and Company, Boston.

Elementary Electrical Testing and Practical Measuring Apparatus. 48 pages. 14.5x23 cm. Paper. 1913. Western Electrical Instrument Co., Newark.

The Golden Deed Book a School Reader, by E. H. Sneath, Yale University, George Hodges, Cambridge, and E. L. Stevens, New York City. Pages xiii+351. 13x19 cm. Cloth. 1913. 55 cents net.

The Way to the Heart of the Pupil, by Hermann Weimer, Biebrich in Rhine. Pages xiii+178. 13x19 cm. Cloth. 1913. 60 cents net.

Everyday English, by Franklin T. Baker, Teachers College, New York, and Ashley H. Thorndike, Columbia University. Pages xv+336. 13x19 cm. Cloth. 1913. 60 cents net. The Macmillan Company, New York.

Arithmetic by Practice, by D. W. Wenemeyer. Pages v+80. 13x19 cm. Cloth. 1913. 50 cents. The Century Company, Union Square, New York.

A First Year in Bookkeeping and Accounting, by George A. MacFarland and Irving D. Rossheim, University of Pennsylvania. Pages viii+

227. 15x23 cm. Cloth. 1913. $1.50 net. D. Appleton and Company, New York.

A High School Algebra, by J. W. A. Young, University of Chicago and Lambert L. Jackson, State Normal School, Brockport, N. Y. Pages x+508. 13x19 cm. Cloth. 1913. $1.15 net. D. Appleton and Company, New York.

An Elementary Treatise on Calculus, by William S. Franklin, Barry MacNutt and Rollin L. Charles, Lehigh University. Pages x+253+20+41. 15x21 cm. Cloth. 1913. $2.00. Published by the Authors, South Bethlehem, Pennsylvania.

Plants and Their Uses, by Frederick L. Sargent, Harvard University. Pages x+610. 13x19 cm. Cloth. 1913. Henry Holt and Company, New York.

The Living Plant, by William F. Ganong, Smith College. Pages xii+478. 16.5x22.5 cm. Cloth. 1913. Henry Holt and Company, New York.

The Origin of Life, by Ralph E. Blount, Waller High School, Chicago. 25 pages. 13x19 cm. Paper. 1913. 10 cents. Scott, Foresman & Company, Chicago.

A Few Suggestions Relating to the Selection of Electrical Measuring Instruments. 24 pages. 15x23 cm. Paper. 1913.

Elementary Electrical Testing and Practical Measuring Apparatus. 48 pages. 15x23 cm. Paper. 1913. Western Electrical Instrument Company, Newark, New Jersey.

BOOK REVIEWS.

Notes on Chemical Research, by W. P. Dreaper, Editor of the Chemical World. Pages x+68. 13x19 cm. Cloth. 1913. $1.00 net. P. Blakistons' Son & Co., Philadelphia, Pa.

A splendid little book which every person doing or intending to do research work in chemistry should possess. In it are stated the conditions which are essential to success in this work. It, in fact, puts one in touch with the fundamental points which one must know before research in chemistry can be successfully performed. There are seven chapters headed as follows: I. Historical Review and Nature of Research; II. Preliminary Survey and Selection of Subject Matter; III. General Procedure and Selection of Methods of Investigation; IV. Chemical and General Scientific Investigation; V. Application of Chemical Research to Industry; VI. Research in Relation to Analysis; VII. General Conclusions.

It will be helpful to any one intending to do research in any line of work. C. H. S.

First Year in Bookkeeping and Accounting, by George A. McFarland and Irving D. Rossheim, University of Pennsylvania. Pages viii+227. 16x23 cm. Cloth. 1913. $1.50 net. D. Appleton and Company, New York.

This is a book in which the author lays particular emphasis on the methods of exposition. It gives a complete beginner's course in bookkeeping and accounting. One of the chief merits of the book is its appeal to the understanding rather than to the memory of the pupil. There are twenty-five chapters in each of which there is an exposition of the particular phase of the work discussed, followed by a number of illustrative problems to be worked out by the pupil. There is enough matter given to provide for a full year's work in higher class of secondary and business schools. The press and mechanical work is of the highest order in book making. Type is large and clear and the subject matter is arranged in splendid order. It merits an extensive sale. C. H. S.

Hygiene for the Worker, by William H. Tolman, Ph.D., Director American Museum of Safety, New York City and Adeliade Wood Guthrie, Department of Research, American Museum of Safety. Edited by C. Ward Crampton, M. D., Director of Physical Training, Department of Education, New York City. Pages vii+231. 1913. American Book Company, New York.

This book as the name implies is purely a book of hygiene for the worker. It takes up a wide variety of topics covering the subject very thoroughly. Some of the specially important chapters are "Choice of an Occupation"; "Occupational Dangers; Accidents"; "Occupational Dangers; Poisons"; "Fatigue"; "What the Worker Has a Right to Expect"; etc. An important feature of the book is the cuts, all woods cuts, representing the most approved methods for retaining the health and guarding against injury and also showing approved safety devices used by modern shops with up-to-date equipment. These drawings are not only very suggestive and educational for the reader, but will serve to put the workman on his guard against poor or dangerous equipment. Altogether the book can not be too highly recommended for the purpose intended and should be in the hands of all teachers and employers who have to do with people not well informed on these subjects. W. W.

Practical Physics for Secondary Schools, by N. Henry Block, Roxbury Latin School, Boston, and Harvey N. Davis, Harvard University. Pages ix+487. 14x19.5 cm. Cloth. 1913. $1.25 net. The Macmillan Company, New York.

This surely is a splendid modern text in every sense of the word. Wise choice has been made in the subject matter presented. Not only is the pupil given the cultural side of physics but is brought into close touch with the practical everyday application. The authors take the right view in saying that everybody should know something about the numerous everyday used machines and instruments now so common on every hand in every nook and corner in the United States. With this thought in mind, they have drawn their illustrative material for the book very largely from those devices which are now in daily use. They have not attempted to make a difficult subject easy by eliminating the hard points but have presented many of the more difficult phases of physics in such a clear and simple manner that almost every secondary school pupil, with the requisite preparation will have no trouble in understanding the text. The authors were wise in not eliminating too much matter from their discussions. While it is true that there is far too much material to be thoroughly covered in one year's work, it gives the instructor considerable latitude in the choice of subjects. Then also the book can be used for a third semester's work. The matter is arranged in a very logical and teachable order. Special emphasis is put upon fundamental principles.

There are many splendid practical problems given. There are 465 cuts and illustrations. These have evidently been selected and executed with great care. They illustrate the points in question accurately. There are several full paged portraits of eminent physicists. The major paragraphs of which there are 489 are numbered and begin with the subject to be discussed in bold face type. At the end of each chapter, a summary of principles presented in that chapter is given, as well as a list of problems and questions. The errors and mistakes are of a nature too minor to notice. It is without doubt one of the best texts of the subject yet published. It doubtless will have an extensive adoption, it merits wide usage. The mechanical and press work is excellent, and the book will stand hard use by the pupil. C. H. S.

The Origin of Life, by Ralph E. Blount, Waller High School, Chicago 25 pages. 13x19 cm. Paper. 1913. 10 cents. Scott, Foresman & Company, Chicago.

A splendid little pamphlet which contains the epitome of sex hygiene as it should be taught in high school. It is divided into three chapters. The Origin of plant and animal children, safeguarding the sex life and moral considerations. It can very properly be made the basis of talks on the subject of sex hygiene by the proper person to high school boys and girls. It is well written and to the point. C. H. S.

Outlines of Physiology, by Edward Groves Jones, A.B., M.D., Professor of Surgery in Atlanta School of Medicine and Allen H. Bunce, A.B., M. D. Third edition, revised. 111 illustrations. Pages xv+372. $1.50 net. 1912. P. Blakiston's Son & Co., Philadelphia.

The purpose of this book can be best described by the following from the preface, "This volume has been prepared with a view of presenting in as convenient form as possible, the essential facts of modern physiology as related to the practice of medicine." It is distinctly a review book for the student of medicine and may be useful to others as a handy reference book. W. W.

Household Bacteriology, for Students in Domestic Science, by Estelle D. Buchanan, M.S., recently Assistant Professor of Botany, Iowa State College and Robert Earle Buchanan, Ph.D., Professor of Bacteriology, Iowa State College and Bacteriologist of the Iowa Agricultural Experiment Station. Figures 360. Pages xv+536. 1913. $2.25 net. The Macmillan Company, New York.

The scope of this work is wider than the title might signify, it being made to cover not only bacteria, but the yeasts, molds and pathogenic protozoa as well. The first three sections of the book are introductory covering the "morphology, classification and distribution of microörganisms," the cultiva and observation of microörganisms and, third, their physiology. Then follows a section on fermentation and another on "microörganisms and health." There is an appendix containing an illustrated key to the "families and genera of common molds."

The book is based on a series of lectures to students in home economics and seems to be developed on a sensible and consistent plan and to be quite comprehensive in its scope. It will prove a very useful book for the general reader interested in home economics as well as for teachers and students of the subject. W. W.

Practical Mathematics, Part IV, Trigonometry and Logarithms, by Claude I. Palmer, Assistant Professor of Mathematics, Armour Institute of Technology. Pages xi+147. 12x18 cm. 1913. Price 75 cents. McGraw-Hill Book Company, New York.

This is the final volume of the series of text-books on practical mathematics designed for classes in evening, trade, and continuation schools. The other volumes have been reviewed on pages 180 and 346 of the current volume of this journal. In the first thirty-two pages the meaning and use of logarithms are explained and a good list of practical problems affords ample drill. The discussion of angle functions and their use in solving problems is clear and can be understood by the shop man. Enough formulas are devolped for use in any problems that may arise in the trades, and there are many applications in physics and engineering. There are nearly 3,000 drill exercises and problems in this series of books, and these with the illustrations and explanations make the series most desirable handbooks for men who must apply elementary mathematics in their work.

H. E. C.

Essentials of Physics for College Students, by Daniel W. Hernig, New York University. Pages ix+353. 16x23 cm. 166 illustrations. Cloth. 1912. $1.75 net. D. Van Nostrand Company, 25 Park Place, New York City.

The name of the author is a guarantee for the high worth of this text. It is an outgrowth of the series of lectures which he has delivered at New York University for several years. It is a book well adopted for use with all classes of students. It will, however, be especially helpful and useful to those who are not to make a specialty of the subject of physics or any of its kindred branches.

A knowledge of elementary physics will be exceedingly helpful in understanding this text. No mathematics beyond plane trigonometry, however, is necessary. There are many paragraphs which will cause the student to make special inquiry and thus extend his knowledge into other texts and fields.

The subject matter is presented in six chapters under the following heads: I. Properties of Matter; Mechanics; II. Heat; III. Waves and Wave Motion; IV. Sound; V. Potential; Magnetism, Electricity; VI. Light. Each chapter closes with a list of experiments bearing on the subjects treated in that chapter. There are many problems scattered through the text. The illustrations have been aptly selected and their drawings well executed. All major paragraphs are numbered and the topic of matter in the paragraph is printed at the beginning in bold face type. The mechanical work in the book is of the highest order. The type is large and paper of a high grade. It is a work that all secondary school instructors in physics should possess. C. H. S.

Commercial Values, an Atlas of Raw Materials of Commerce and Commercial Interchanges, by Mark Jefferson, Professor of Geography in the Michigan State Normal College. 64 pages. 17.5x26 cm. Paper. Ginn and Company, Boston.

This atlas consists of thirty-three full page maps of the world, all of the same size and all on the Mollweide projection. This facilitates comparisons. Twenty-three of the maps show the distribution of the leading raw materials of commerce, each map showing but one product. There are numerous insects showing details of distribution. Facing each map there is a list of questions for the student. The questions are to the point and well chosen. Their number ranges from three to sixteen per map. Four maps show the foreign sales and four maps the foreign purchases of the United States, United Kingdom, Germany, and France. There are also maps on population, steamer routes, and rainfall. All data given are for the year 1909. This is the latest date for which certain statistics are available.

The atlas give the production not by measure nor by weight but in value, in terms of American farm value. This is a unique feature of the book and one in which it differs from all other statistical atlases. By a clever device the author shows upon the maps at once the money value and the distribution. He takes five symbols each representing a certain number of dollars; these symbols are used directly upon the maps.

The last page contains a table of values of raw materials by continents and countries, the leading country being indicated for each product.

This book will be of pronounced service for classes in commercial geography. High school and normal school students can readily understand and use it. The convenient arrangement and the choice of material show the impress of a skilled teacher. There is, however, one criticism which must be made and that is that the book is published without a table of contents. This is a serious omission. J. H. S.

Teachers' Manual of Biology, a Handbook to Accompany the Applied Biology and the Introduction of Biology by Maurice A. Bigelow and Anna N. Bigelow, by Maurice A. Bigelow, Professor of Biology in Teachers College, Columbia University. Pages ix+113. 40 cents net. 1912. The Macmillan Company, New York.

This book as will be seen by the title page quoted above is more complete than the usual handbook written to accompany texts. It contains besides explanations—many discussions of various topics, references to authorities, suggestions as to methods etc. It will be a very helpful book for the conscientious teacher—especially so for those who are beginning the work or are not well grounded in their preparation.

W. W.

Textbook of Anatomy and Physiology for Nurses, by Elizabeth R. Bundy, M. D., Member of Medical Staff of the Woman's Hospital of Philadelphia; Gynecologist of the New Jersey Training School for Nurses. Second edition, revised and enlarged, with a glossary and 215 illustrations, 42 of them in color. Pages xii+335. $1.75. 1913. P. Blakiston's Son and Co., Philadelphia.

There are 88 pages of new matter and 24 new illustrations incorporated in this edition largely by greater elaboration of various important topics. The book seems to be well worked out for the purpose intended. The statements are all concise and clear and by the free use of black-faced type and italics it is easy for the student to grasp the essential points on each page. The presentation of the various topics is excellent in method and so far as the reviewer can determine the book should be successful in the hands of the student. For the general reader or teacher the book can be recommended for its clearness and brevity, making a handy reference work.

W. W.

Elementary Biology, Animal and Human, by James Edward Peabody, A.M., Head of Department of Biology, Morris High School, New York City, and Arthur Ellsworth Hunt, Ph.D., Head of the Department of Biology, Manual Training High School, Brooklyn. Illustrations 137+54. Pages xiv+194+212. $1.00 net. 1912. The Macmillan Company, New York.

The present volume was preceded by a volume on Plant Biology making with the addition of this volume a complete presentation of the subject of elementary biology. The teachers of New York have been very active in issuing books on biology intended to fit the particular needs of schools of that state and comply with the laws of the state. Teachers of other sections of the country not hampered by state laws and regents will not as a rule be impressed with these books for the reason that they are made to fit a certain condition regardless of the needs of the subject in general. The idea of tacking human physiology and hygiene on to the study of biology has never appealed to the reviewer. It will sooner or later be recognized that a study of plants plus a study of animals plus a study of man is not after all biology at all. It is still botany, zoölogy and physiology despite the labelling. The real biology will interweave the study of animals and plants in such a way as to be a study of life in its various phases.

The present work seems to be a very good presentation of the subject from the author's point of view. The laboratory directions are included and somewhat over half the space is given to man. The mammals receive scant treatment under the head of "additional animal studies." Only six groups of animals are studied—the insects, birds, frogs, fishes, crayfishes and their relatives and paramecium and its relatives. The other groups are put into the chapter noted above.

W. W.

College Algebra, by William B. Fite, Professor of Mathematics in Columbia University. Pages v+283. 14x19 cm. 1913. D. C. Heath & Co., Boston.

For many years the course in algebra has been, in the opinion of the writer, the most barren field in college mathematics. To the student it has seemed, for the most part, to consist of a collection of dissertations on unrelated subjects having no practical use.

By omitting topics of little practical value and by presenting the essentials in a clear and concise manner Professor Fite has produced a most excellent text-book in college algebra. The following are the distinctive features: The review of high-school algebra with problems based on geometry, physics, and easy analytic geometry; equivalent equations; graphical solutions; clear-cut discussion of mathematical induction; all of theory of equations leading up to the solution of numerical equations and practical problems; a brief presentation of infinite series that can be understood by the average student, in which the symbol for infinity and the word itself is not used, except as it is implied in the phrase "infinite series." For the sake of a clear understanding of these topics on the part of the student this book should have a wide use. H. E. C.

Practical Geometry and Graphics for Technical Students. Pages viii+621. 13x19 cm. Price $2.00. *Practical Mathematics for Technical Students.* Pages viii+513. 13x19 cm. Price $1.50. *Edward L. Bates, Lecturer on Geometry at the L. C. C. School of Building, Brixton, London, and Frederick Charlesworth, Lecturer on Practical Mathematics and Geometry at the Southwestern Polytechnic Institute, London.* 1912. D. Van Nostrand Co., New York.

Practical Geometry and Graphics presents in a direct and simple way the essentials of the subjects, and applies the principles to the solution of problems that constantly arise in practical work. It has found a place in some technical schools in England and serves as a most useful handbook for engineers, architects, and artisans engaged in the constructive arts. The book is divided into three sections: (1) Plane Geometry, 282 pages, dealing with the construction of figures, measurement, areas, surfaces, volumes, loci, and conic sections. (2) Graphics, 135 pages, presenting in a most interesting manner the problems of graphical algebra, use of squared paper, vectors, determination of stresses, moments, and kinematical diagrams. (3) Descriptive Geometry, 188 pages, with many applications. The diagrams, numbering 566, add much to the usefulness of the book to the man who reads it without the help of an instructor.

Practical Mathematics has been designed to meet the needs of technical students and artisans, and covers a much wider field than the preceding book. No previous knowledge of the subject is assumed. It is believed that the book contains all the mathematics that the average technical student or practical man may require to enable him to work out his technical problems. This seems to be true so far as the algebra, geometry and trigonometry are concerned. Though these subjects are presented in a very practical way, there is not lacking a sufficient drill in orderly reasoning and clear thinking. The practical man finds a use for squared paper as worked out in this book. It is interesting to note that the objection to the use of squared paper and practical mathematics in general comes from the college professors of pure mathematics who write text-books for secondary schools, and the pure mathematician in the high school. The last seventy-six pages are devoted to the methods of calculus and give one a good working knowledge of the subject. A study of this book by every teacher of secondary-school mathematics would tend to make his classroom work more beneficial to the average pupil. H. E. C.

The Development of the Human Body, A Manual of Human Embryology, by J. Playfair McMurrich, A.M., Ph.D., LL.D., Professor of Anatomy in the University of Toronto. Fourth edition, revised and enlarged, with 285 illustrations. Pages viii+495. $2.50 net. 1913. P. Blakiston's Son & Co., Philadelphia.

This book is intended for the use of medical students and the name of the author is sufficient guarantee of its worth. The present edition is considerably enlarged and the subject matter has been recast to incorporate changes necessitated by recent additions to our knowedge of human embryology. The illustrations are good and those interested in further study of the subject will be pleased at the references to literature appended to each chapter. W. W.

Gas Analysis, by L. M. Dennis, Cornell University. Pages xvi+434. 110 cuts. 14x20 cm. Cloth. 1913. $2.10 net. The Macmillan Company, New York.

This book follows the general plan of *Hempels' Methods of Gas Analysis.* It contains, however, much new material and is in every way an exposition of the latest and most expeditious methods of gas analysis. The method of procedure has been entered into with considerable detail, so that the user of the text will not lose valuable time in interpreting obscure descriptions. There are many references to original articles given in the text at the proper places. The major part of the book is devoted to the discussion of technical gas analysis, this being the field in which the greatest part of the work of the gas analyst lies. There are 110 cuts or illustrations given in the text. These have been remarkably well chosen and executed, every detail of the drawing being clear. One will have no difficulty in constructing the apparatus from the descriptions given. The book is well written, diction clear and statements accurate. There is a splendid table of contents of the twenty chapters. The major paragraphs begin with bold face type, the topics corresponding with those given in the contents. A very complete index of twenty-two pages is appended. The type is 10-point similar to the larger type in this *Journal,* The press work is excellent and the book well made in every particular.

C. H. S.

School Hygiene, by Fletcher B. Dunbar, United States Bureau of Education. Pages xi+369. 14x20 cm. Cloth. 1913. $1.25 net. The Macmillan Company, New York.

This splendid book should be in the library of every teacher and parent in the land. It treats of that phase of education which, fundamentally, is more vital than knowledge which is gained by the study of books. It discusses those subjects and things which if put into execution would make the environment of the school such that the child would rather be there than not. Much valuable information and knowledge have been collected here. It will be one influence in convincing teachers that it is more important to instruct children how to become real men and women than to become familiar with certain books and the matter contained therein. Get the former, the latter will follow. The book makes interesting reading for any one. It is written in an interesting manner. There are twenty-six chapters, the main paragraphs of which begin with bold face type. Each chapter closes with a suggestive list of topics for investigation, as well as giving a list of references of books and papers bearing on the points treated in the chapter. There are fifty-one figures and illustrations. A very complete index of five pages is given at the end. Readers of this imperfect review will help along the cause of proper education by possessing themselves of a copy and telling their colleagues about it.

C. H. S.

Arithmetic by Practice, by D. W. Werremeyer, High and Manual Training School, Ft. Wayne, Ind. Pages iv+80. 13x19 cm. Price 50 cents. 1913. The Century Co., New York.

This is a collection of about 800 problems for the use of pupils in the seventh and eighth grades. The problems involve common fractions, decimal fractions, applications of percentage, and measurement and mensuration. It is the hope of the author that the book may be of use in schools of education and in normal schools in furnishing material for a twelve weeks' course in arithmetic. H. E. C.

Francis W. Parker School, New York. The Morning Exercise as a Socializing Influence, by the Faculty. 198 pages. 15x23 cm. Paper. 1913. 35 cents. Published by the school, Chicago.

This is a splendid and remarkable exposition of the nature, utility and social influence of the morning exercise. It is exceptionally valuable from the fact that it represents the results of twelve years' study in this excellent school, of this phase of school work from almost every possible angle. Some form of opening exercise has been carried out every day since the school was founded. The entire faculty has shared in the compilation of the book. It not only represents ideas of the individual member but also the ideas of committees from the faculty. Teachers interested in this kind of school work should possess themselves of a copy. C. H. S.

The Way to the Heart of the Pupil, by Dr. Hermann Weimer. Biebrich on Rhine, translated by J. Remsen Bishop and Adolph Niederpruem, Eastern High School, Detroit. Pages xiii+178. 13x17 cm. Cloth. 1913. 60 cents net. The Macmillan Company, New York.

A timely book for teachers to read and ponder over. Parents, too, would do well to read it. It was written by a keen observer and teacher of long experience. It has been given a most enthusiastic reception whereever read. The thinker and worker in school affairs, almost without exception, will upon it put his stamp of approval. It pleads for the extermination of the mechanical measurement of a teacher's efficiency and substituting therefor the result of his personality measured in terms of the high character of boys and girls who have been trained by coming under his influence. It pleads too for a closer relationship between teacher and pupil. All American teachers should read it and incorporate into their vocation the high ideals it teaches. C. H. S.

Catalogue of High School and College Textbooks. Pages xxviii+572. 13x20 cm. Cloth. 1913. Ginn and Company, Boston.

The appearance of this splendid catalogue, which is a real book shows that this firm is still progressive. They have learned the knack of making a catalogue of their publications so complete and interesting that folk put it into their library, among other books, and use it as a book of reference. Its purpose is one of utility. It is divided into three parts. Part I is descriptive of "Some New and Forthcoming Publications." Part II, which is the major portion, is given to a description of their high school and college books. Here the texts are arranged alphabetically by authors under topics and special subjects. Part III is a complete index and price list. It gives the titles, prices and code words of their publications.

Throughout the catalogue the descriptions of the books are necessarily short, but they are to the point and give the reader a good idea of the scope of the book described. In most cases the description is supplemented by testimonials from teachers and users of the texts.

The volume represents the acme of book making. The paper is of a fine quality and the press work is of the highest degree of workmanship. Every principal and superintendent should possess a copy. C. H. S.

The Idea of the Industrial School, by Georg Keischensteiner, translated from the German by Rudolf Pintner. Pages xi+110. 12.5x18 cm. Cloth. 1913. 50 cents net. The Macmillan Company, New York.

A splendid epitome of just what is meant by industrial education in the highest and truest sense of the term. The study of this little volume of both adherents and opponents of this phase of education will set aright any misunderstanding which either party may possess concerning industrial education. One's view of this side of education will be more firmly fixed in its favor by reading the book. It is clearly and concisely written.

C. H. S.

Chemical Theory and Calculations, by Forsyth J. Witson and Isidor M. Heilbun, Royal Technical College, Glasgow. 138 pages. 12.5x18.5 cm. Cloth. 1912. $1.00 net. D. Van Nostrand Co., New York.

A valuable book in which the essentials of chemical theory are given separately from the discussions of descriptive chemistry. It will be a helpful book for the university student and can be used with profit in the advanced classes in chemistry in high school. The matter is arranged as far as possible in logical sequence. There are many practical problems given in the test. Particular problems are given at the end of the chapter in which this theory is discussed. It is a thoroughly reliable and modern presentation of the subject. A table of atomic weights is appended as well as pages on which the answers to the problems are given. C. H. S.

A High School Algebra, by J. W. A. Young, Associate Professor of the Pedagogy of Mathematics in the University of Chicago and Lambert L. Jackson, formerly Professor of Mathematics in the State Normal School, Brockport, N. Y. Pages x+508. 14x19 cm. Price $1.15. 1913. D. Appleton & Co., New York.

All the topics included in the standard year-and-a-half courses in high school are contained in this volume. It is planned in such a way that it can be used for a continuous course or for a divided course in which a year of geometry intervenes between the first and second courses in algebra.

The following are said to be the attractive features: "(1) The relation of algebra to arithmetic is made clear. (2) Oral and written exercises make teaching easy. (3) Processes are immediately applied to equations. (4) Nearly 7,000 exercises furnish plenty of practice. Summaries clinch the theory. (5) There are abundant concrete problems within the pupil's capacity. (6) the processes are reviewed and extended in the second year work. (7) Fractional exponents are used to explain radicals. (8) The historical and biographical notes add interest to the subject. (9) The answers are simple and convenient for checking. (10) Problems requiring data of geometry are deferred to the second year." Teachers who wish to conserve the old methods and aims of instruction in algebra will be interested in this book.

H. E. C.

Academic Algebra, by George Wentworth and David Eugene Smith. Pages v+442. 14x19 cm. Price $1.20. 1913. Ginn & Company, Boston.

The name is well chosen, and the book will prove of interest to conservative teachers. The things that make it a first-class text-book have been stated as follows, "It excludes technical examples and problems and presents those concerned with modern conditions; hence all pupils are interested. It recognizes the demand for making use of the function concept. It introduces oral algebra and makes clear many of its uses and applications. It uses graphic work just to the extent to which it is helpful in contributing to the idea of function and to an understanding of the nature of the equation. It reduces the difficulties of the fundamental operations to a safe minimum."

H. E. C.

SCIENCE AND MATHEMATICS SOCIETIES.

Under this heading are published in the March, June, and October issues of this journal the names and officers of such societies as furnish us this information. We ask members to keep us informed as to any change in the officiary of their society. Names are dropped when they become a year old.

AMERICAN ANTHROPOLOGICAL ASSOCIATION.

President, Professor Roland B. Dixon, Harvard University; *Secretary*, Professor George Grant MacCurdy, Yale University; *Treasurer*, Mr. B. T. B. Hyde, New York; *Editor*, Mr. F. W. Hodge, Bureau of American Ethnology.—113.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

President, Edmund B. Wilson, Columbia University, New York, N. Y.; *Vice-Presidents*, Section A—Frank Schlesinger, Allegheny Observatory, Allegheny, Pa.; Section B—Alfred D. Cole, Ohio State University, Columbus, Ohio; Section C—Arthur A. Noyes, Massachusetts Institute Technology, Boston, Mass.; Section D—Ozni P. Hood, U. S. Bureau of Mines, Washington, D. C.; Section E—Jacob S. Diller, U. S. Geological Survey, Washington, D. C.; Section F—Alfred G. Mayer, Carnegie Institute of Washington, Washington, D. C.; Section G—Henry C. Cowles, University of Chicago, Chicago, Ill.; Section H—Walter B. Pillsbury, University of Michigan, Ann Arbor, Mich.; Section I—(no election); Section K—(no election); Section L—Philander P. Claxton, Commissioner of Education, Washington, D. C.; *General Secretary*, Harry W. Springsteen, Western Reserve University, Cleveland, Ohio; *Secretary of the Council*, W. A. Worsham, Jr., University of Georgia, Atlanta, Ga.; *Secretaries of Sections*, Section A—F. R. Moulton, University of Chicago, Chicago, Ill.; Section C—(no election); Section D—Arthur H. Blanchard, Columbia University, New York, N. Y.; Section F—Herbert V. Neal, Knox College, Galesburg, Ill.; Section G—W. J. V. Osterhont, Harvard University, Cambridge, Mass.; Section H—George G. MacCurdy, Yale University, New Haven, Conn.; Section K—(no election); Section L—Stuart A. Courtis, Home and Day School, Detroit, Mich.; *Place of Next Meeting*, Atlanta, Ga.; *Date of Next Meeting*, Convocation Week, 1913-1914.—113.

AMERICAN ASSOCIATION OF MUSEUMS.

President, Benamin Ives Gilman, secretary of the Museum of Fine Arts, Boston; *First Vice-President*, Oliver C. Farrington, curator of geology, Field museum of Natural History, Chicago; *Second Vice-President*, Arthur Hollick, curator of fossil botany, New York Botanical Garden, New York; *Secretary*, Paul M. Rea, director, The Charleston Museum, Charleston, S. C.; *Treasurer*, W. P. Wilson, director, The Philadelphia Museums, Philadelphia; *Councilors* (1913-16), Henry L. Ward, director, Public Museum of the City of Milwaukee, Milwaukee; Edward K. Putnam, director, Davenport Academy of Sciences, Davenport, Iowa.

Milwaukee is the meeting place for 1914.—613.

AMERICAN MATHEMATICAL SOCIETY.

President, Professor E. B. Van Vleck, University of Wisconsin; *Vice-Presidents*, M. W. Hoskell and B. O. Peirce; *Secretary*, F. N. Cole; *Treasurer*, J. H. Tanner; *Librarian*, D. E. Smith; *Committee on Publication*, F. N. Cole, E. W. Brown and Virgil Snyder; Chicago Section, *Secretary*, H. E. Slaught; San Francisco Section, *Secreatry*, T. M. Putwam; Southwestern Section, *Secretary*, O. D. Kellogg.—113.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

President, Ross G. Harrison, Yale University; *Vice-President*, E. M. Worsham, Atlanta, Ga.; *Second Vice-President*, Wilmon Newell, College Station, Texas; *Secretary*, A. F. Burgess, Melrose Highlands, Mass.; *Annual Meeting*, Atlanta, Ga., December, 1913.—113.

AMERICAN NATURE-STUDY SOCIETY.

President, Anna B. Comstock, Ithaca, N. Y.; *Vice-Presidents*, E. B. Babcock, Cal.; M. A. Bigelow, N. Y.; Otis W. Caldwell, Ill.; Stanley Coulter, Ind.; *Secretary*, Elliot R. Downing, University of Chicago.—113.

American Society of Naturalists.

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Association of Mathematical Teachers in New England.

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Association of Teachers of Mathematics in the Middle States and Maryland.

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Astronomical and Astrophysical Society of America.

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COLORADO MATHEMATICS ASSOCIATION.

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EASTERN ASSOCIATION OF PHYSICS TEACHERS.

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